Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

FEBRUARY 1961

Ohio

FORGED SLEEVES and Cast Steel or Forged Steel Arbors for Back-Up Rolls

A Complete Back-Up Roll Service

Ohio Steel, manufacturers of all types of iron, steel and forged steel rolls, announces a new complete back-up roll service.

Operations Now Include:

- Alloy Cast Steel Back-up Rolls and Arbors
- Forged Steel Back-up Rolls and Arbors from vacuum poured, degassed steel.
- Custom forged Back-up Roll Sleeves from vacuum poured, degassed steel applied to new or used cast steel or forged steel arbors.
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If you're looking for a complete back-up roll service that'll meet your most exacting specifications, contact your nearest Ohio roll sales engineer.

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- Ohioloy Rolls
- Ohioloy "K" Rolls
- Hintuff Rolls
- Double-Pour Rolls
- Chilled Iron Rolls
- Nioloy Rolls
- Denso Iron Rolls
- Nickel Grain Rolls
- Special Iron Rolls
- Forged Steel Rolls

THE OHIO STEEL FOUNDRY CO., LIMA, OHIO

PLANTS AT LIMA AND SPRINGFIELD, OHIO . . . Centrally at the center of the steel industry

"Give Us The Runway.... and We'll Lift The World"

THE ALLIANCE MACHINE COMPANY has, through superior design and quality workmanship, become the World's Greatest builders of the World's Largest Cranes.
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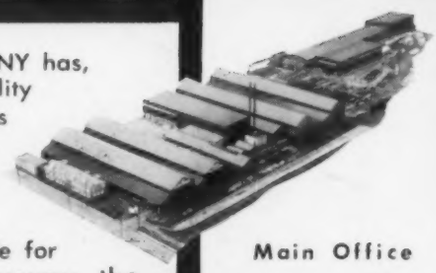

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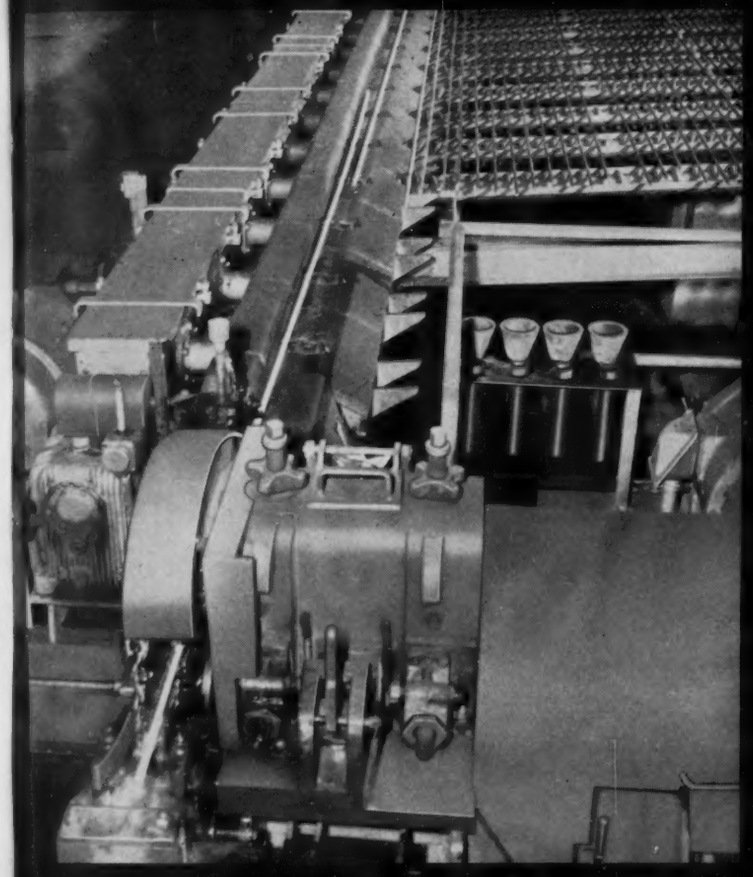
the Alliance
machine company

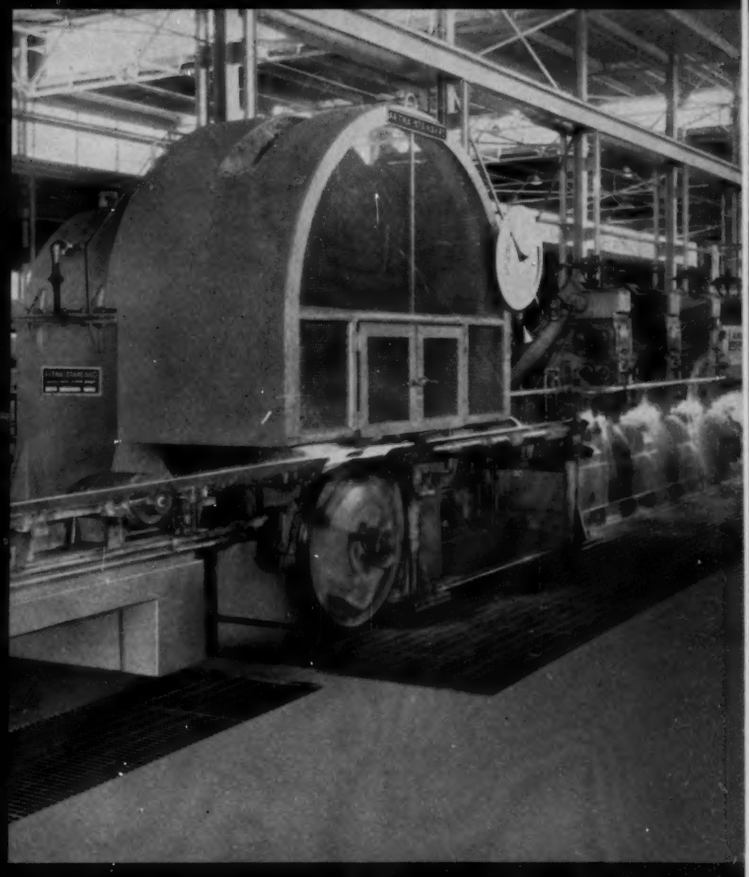
Overhead Cranes ■ Gantry Cranes ■ Mill Cranes and Equipment ■ Hot Metal Cranes ■ Ladle Cranes ■ Stripper Cranes ■ Soaking Pit Cranes ■ Soaking Pit Cover Cranes ■ Charging Machines ■ Furnace Chargers ■ Slab Handling Cranes ■ Bucket Cranes Magnet Cranes ■ Mold Yard Cranes ■ Skull Cracker Cranes ■ Ingot Buggies ■ Run-Out Tables ■ Car Dumpers ■ Special Mill Equipment ■ Ore & Coal Bridges ■ Loading & Unloading Towers ■ Forging Manipulators ■ Forging Cranes ■ Power House & Dam Cranes ■ Dock & Pier Handling Equipment ■ Research, Development & Engineering Service ■ Licensees and Manufacturing Facilities in Other Countries.

2 REASONS... FOR

HIGH-SPEED PRODUCTION OF PIPE... (Small diameter)

by C. W. Mills, E. W. Mills, Seamless or Stretch Reducing





ROTARY KICKOUT

- Transfers pipe to Cooling Beds at high speeds.
- Simple mechanical design.
- No great gap required between pipe lengths.
- Pipes are staggered in Kickout and come to a complete rest in Kickout before being transferred onto the Cooling Bed.

ROTARY FLYING HOT SAW

- Cuts any desired length at close length tolerances.
- Length of cut can be changed at full mill speed.
- Runs continuously at high speeds.
- 24 Rotary Flying Saws in successful operation. Latest saw has been tested by actual running at speeds of 2000 F.P.M. and higher.

Aetna-Standard Division • 300 Sixth Avenue • Pittsburgh 22, Pennsylvania

OTHER FEATURES OF AETNA-STANDARD PIPE MILLS:

Stretch Reducing—Simple and rugged design allows fast changing of mill.

Cooling Beds—Screw type with Cooling Tanks. Automatic pipe handling for dividing of pipe and cropping if desired.

Uncoilers—Automatic handling of coils. No manual labor required.

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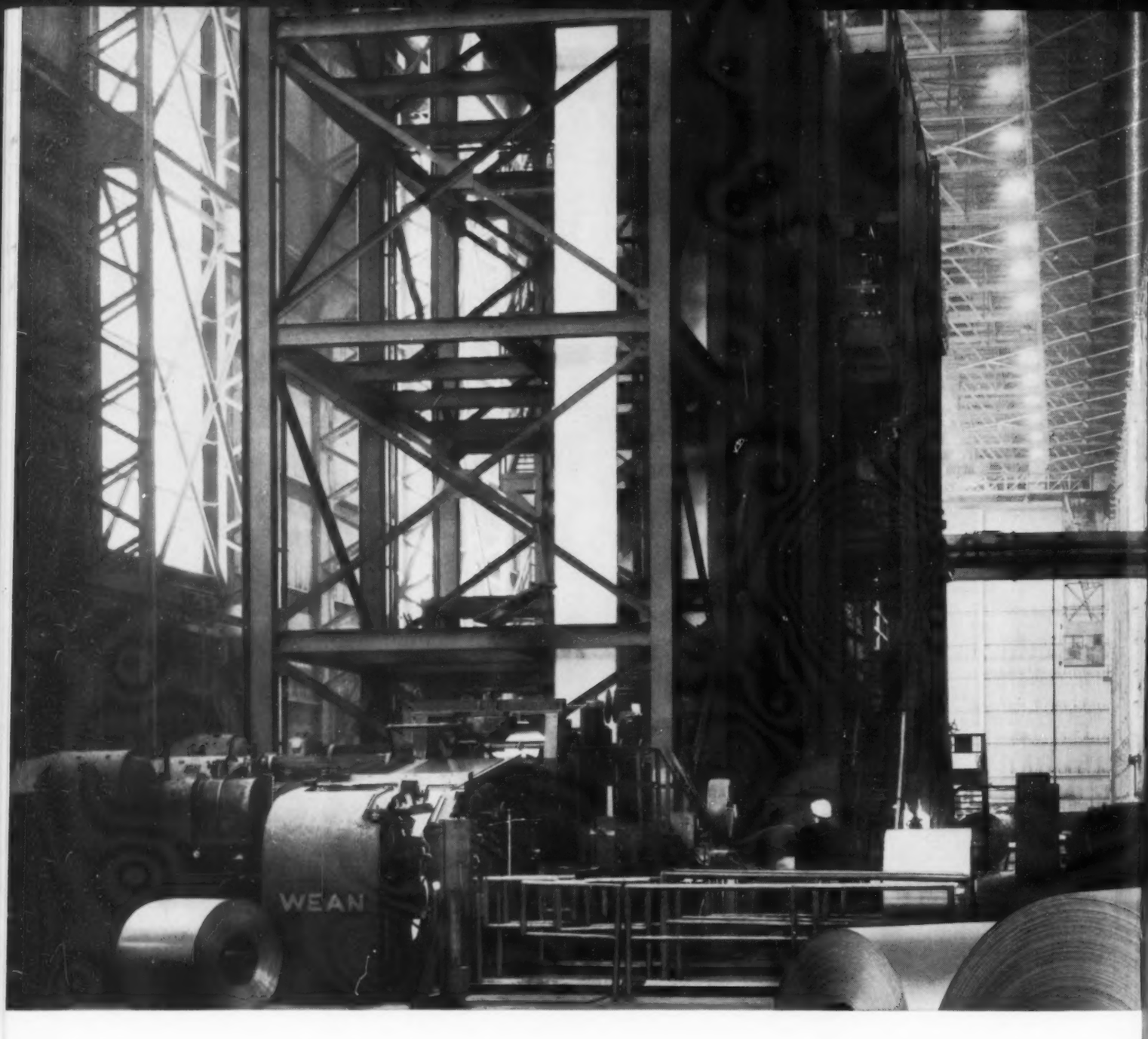

Kaiser Steel adds Wean Annealing Line in expansion of West Coast plant

This continuous tin plate annealing line marks the eighth Wean continuous processing facility installed at Kaiser Steel Corporation's Fontana, California plant, to service that company's customers for finished steels on the West Coast.

The Fontana line is capable of handling 30,000 lb. coils, with a maximum I.D. of 16½", and an O.D. of 66". Operating at speeds up to 1200 feet per minute, the new line can process strip from .006" to .015" thick, and from 18" to 38" wide.

Other Wean continuous processing equipment at Kaiser's Fontana plant includes a hot strip pickle line, two side trimming and recoiling lines, an electrolytic cleaning line, two electrolytic tinning lines, and a tin plate shearing line.

Wean's "creative engineering" can help you meet your customer requirements.

WEAN

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Published Monthy by

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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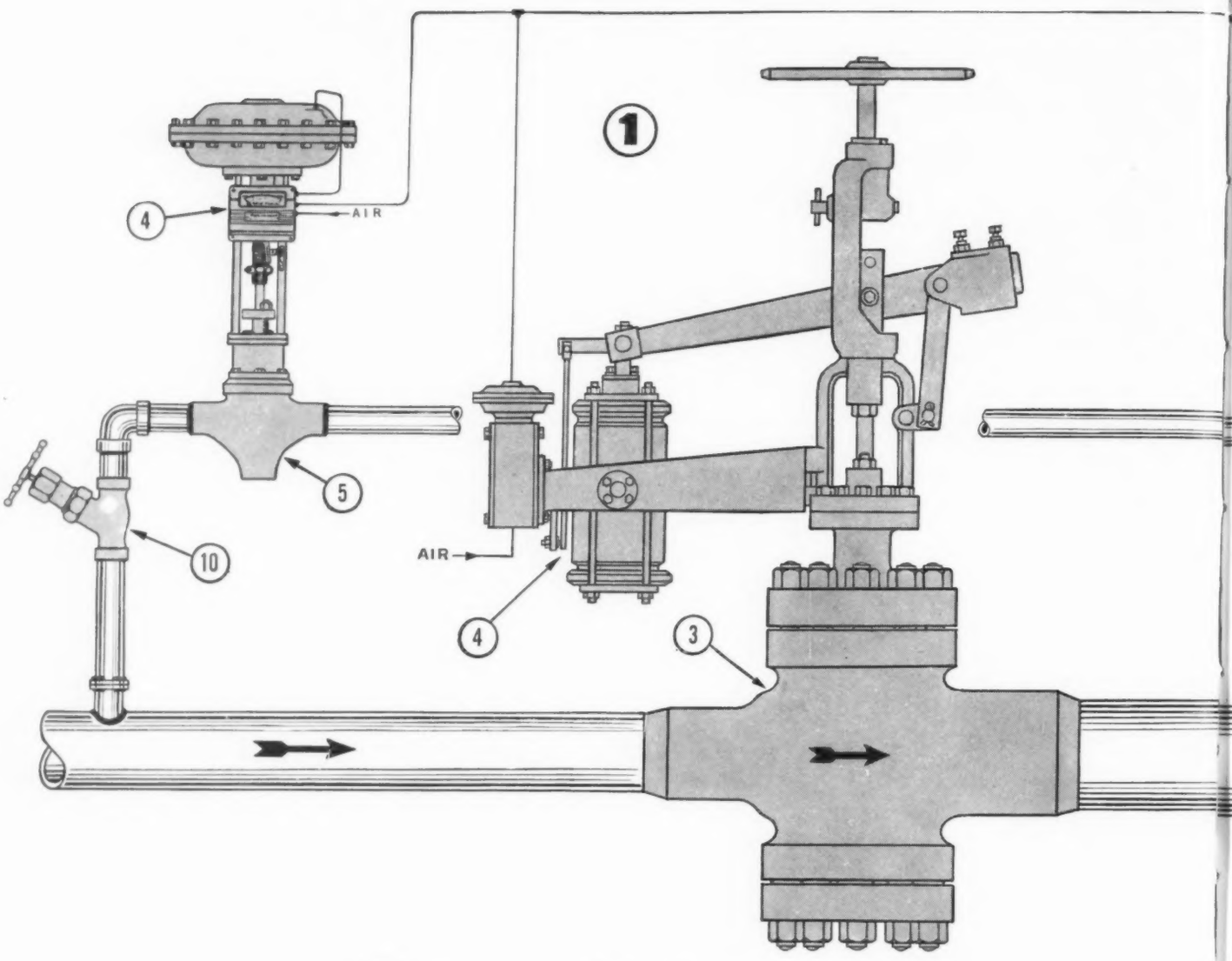
Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds).....$ 7.50 per year
Subscription price in foreign countries (U. S. funds).....$10.00 per year

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Second-class mail privileges authorized at Easton, Pa. This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.122.

Pressure Reducing and



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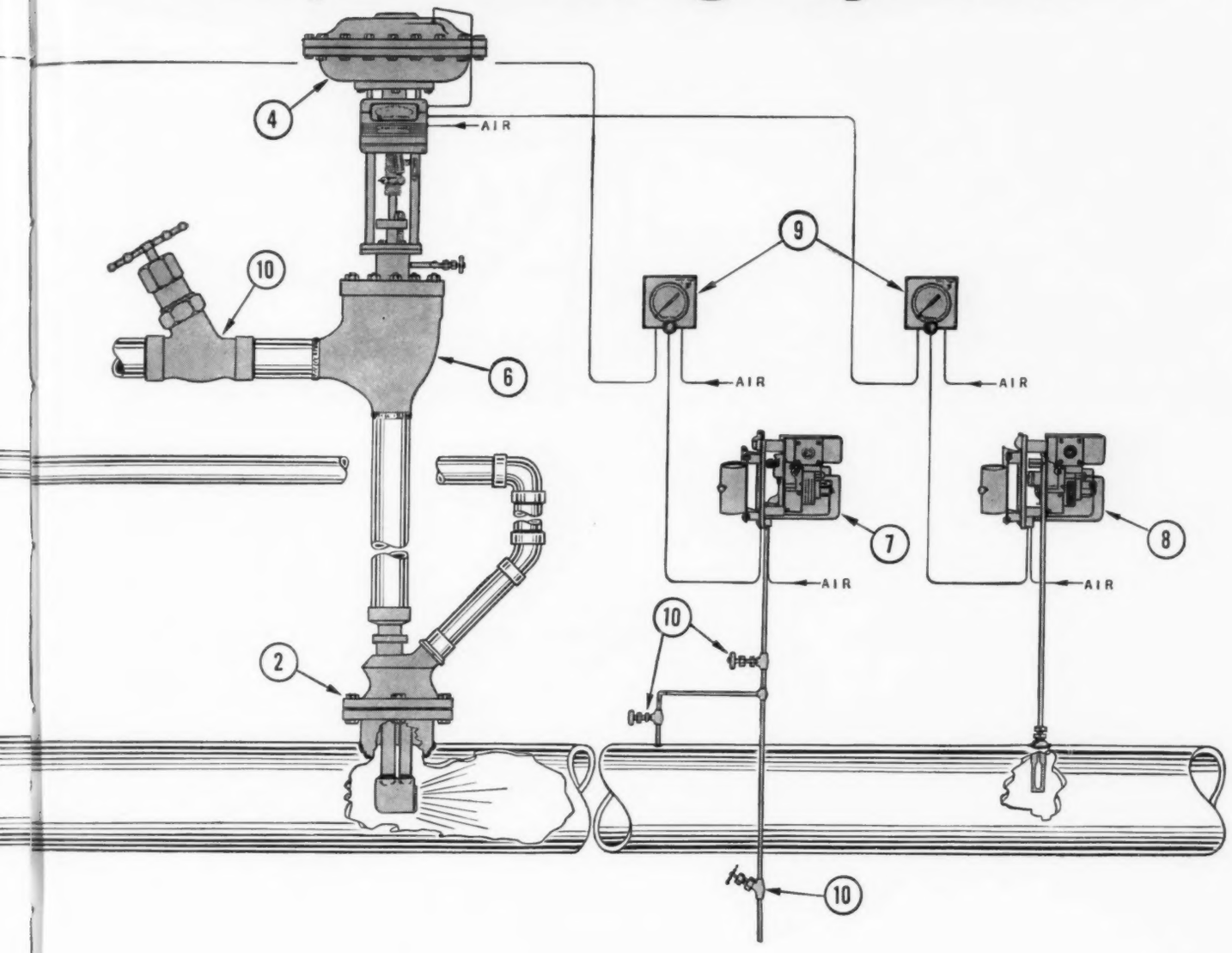

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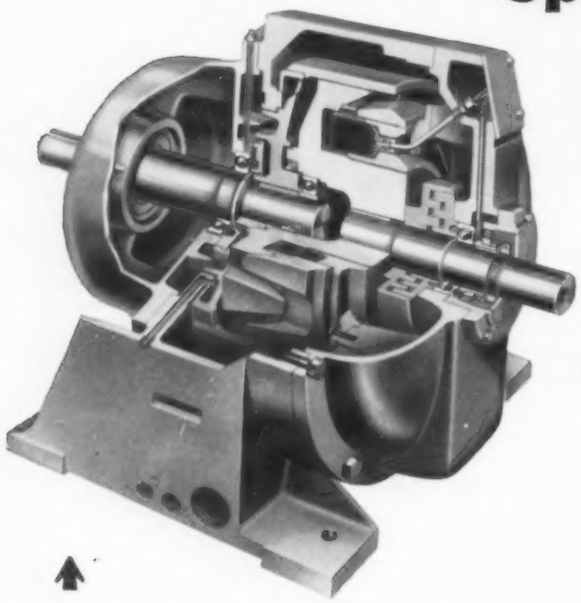

Dynamatic Liquid-Cooled Couplings provide infinitely adjustable speeds for nearly every application from 3 to 75 HP. Note the absence of slip rings, brushes, and commutators. Heavy-duty types with capacities up to 5,000 HP are also available.

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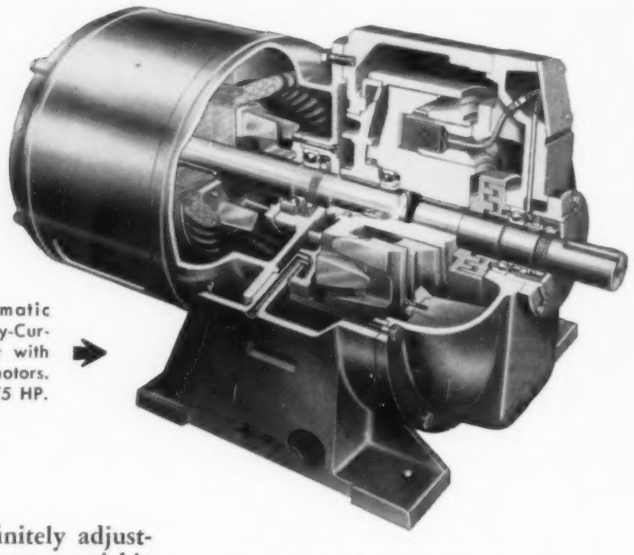
LIQUID-COOLED EDDY-CURRENT COUPLINGS and DRIVES



"Dynaspede" Drives are Dynamatic Liquid-Cooled, Stationary-Field Eddy-Current Couplings mounted integrally with standard, D-flange, squirrel cage motors. Available in capacities from 3 to 75 HP.

Here's Why—

Dynamatic Liquid-Cooled Couplings and Drives provide infinitely adjustable speed from a constant speed source—or constant speed from a variable speed source. They operate on standard alternating current. Rotary power is transmitted through the coupling by an electromagnetic reaction between the driving and driven members of the unit—there is no mechanical contact of rotating members to cause wear and require adjustment or replacement.

A wide range of standard and special control features may be obtained from a remotely-mounted electronic control system. Infinite speed adjustment, constant speed control, on-off clutch control, torque limit, acceleration control, inching, and threading are a few of the many functions available. The addition of an eddy-current brake to standard couplings or drives provides smooth, cushioned stops and controlled deceleration.

Liquid-Cooled Dynamatic Couplings and Drives deliver more horsepower than other types of the same physical size, thus conserving space in a busy machine area. Efficient heat dissipation permits continued operation at low speeds, or stall with full load.

Completely enclosed, Dynamatic liquid-cooled units are protected from dust, dirt, and other atmospheric impurities. Dynamatic design involves no brushes or slip rings; there is no possibility of arcing. With simple modification these units can be made explosion-resistant for hazardous applications.

Infinitely Adjustable Speeds from AC Power

★

Full-Torque Starts

★

Wide Range of Control Functions

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No Slip Rings, Brushes or Commutators

★

Completely Enclosed Design

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Elbolift at J & L stacks coils in the warehouse, loads boxcars and flat-bed trucks.

ELBOLIFT...Littlest BIG truck in the steel industry

AUTOMATIC's Elbolift measures only 80″ high, yet can stack coils weighing up to 25,000 lbs. as high as 120″. Because the truck is narrower than the width of a palletized coil, the truck can stack coils close together, fully utilizing all available storage space.

In addition, the Elbolift can out-maneuver any other truck in its capacity range of 12,000 to 25,000 lbs. Its compact stand-up end control design permits it to load as many as eight coils into a boxcar in nine minutes! Its unique lever action lifting mechanism enables the Elbolift to load coils onto over-the-road flat bed trailers in one operation without extra maneuvering to center the load on the trailer.

These features mean more coils handled per truck per day . . . less capital investment for handling equipment . . . more production from existing facilities. For the full story of how AUTOMATIC's industrial trucks can cut coil handling costs, mail coupon for Heavy Duty Trucks Facts and Factors brochure. Mail it today!

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Please send me free copy of "Heavy Duty Trucks Facts and Factors" brochure.

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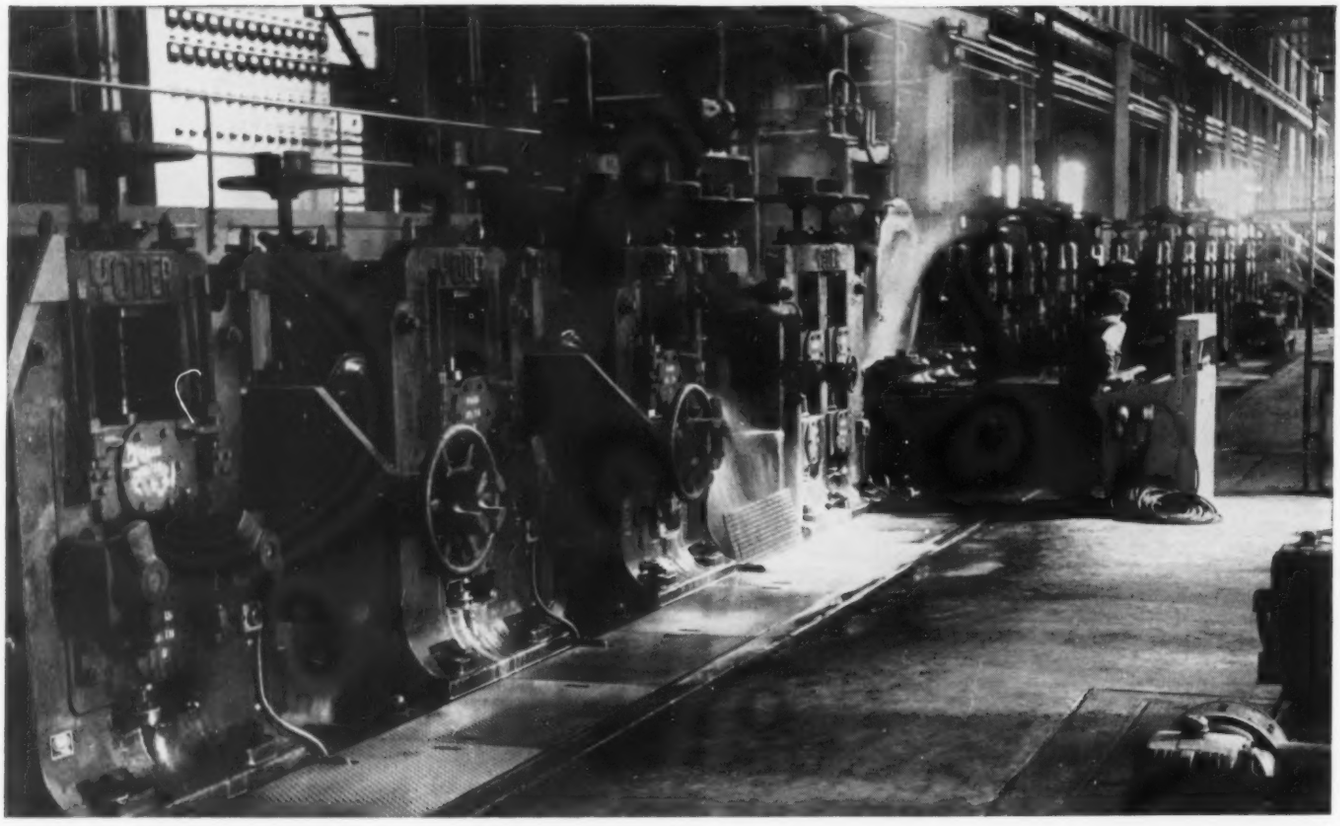

Yoder equipment produces 10, 12, and 14-inch electric-weld pipe at Kaiser Steel

The Kaiser Steel Company, Fontana, California —like many other primary metal suppliers— utilizes the speed, efficiency and dependability of Yoder-engineered equipment. Shown above is the Kaiser-owned Yoder electric-weld pipe mill used for the high speed production of 10, 12, and 14-inch pipe.

Yoder pipe and tube mills are engineered for ferrous or non-ferrous pipe and tube from $\frac{5}{16}$-inch to 26-inch diameters.

For complete detailed information on Yoder Pipe and Tube Mills or Slitting Lines, write for either of these free books:

- ☐ Yoder Pipe Mill Manual
- ☐ Yoder Slitting Equipment Manual

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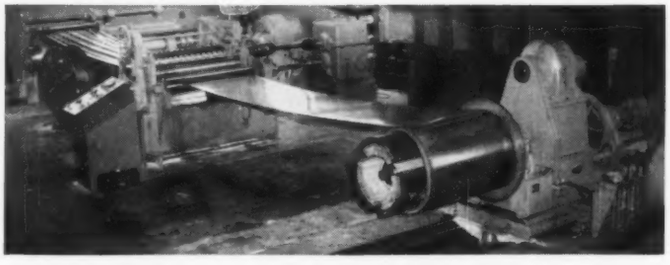
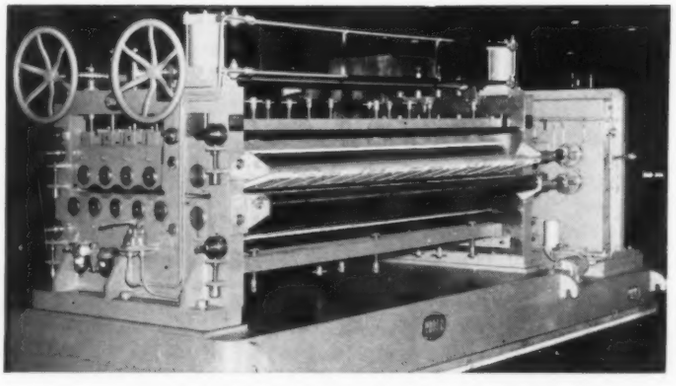


Complete Yoder Slitting Line



Nine-roll Yoder Leveller

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PIPE AND TUBE MILLS (ferrous or non-ferrous)
COLD ROLL FORMING MACHINES
ROTARY SLITTING LINES

LINK-BELT Fan-cooled Worm Gear Speed Reducers

right speed... at right angles

SINGLE, DOUBLE AND HELICAL WORM GEAR COMBINATIONS!

There's a Link-Belt worm gear speed reducer for *every* right-angle need. Link-Belt offers industry's *most complete* range of types and sizes . . . in single and double reductions . . . horizontal and vertical mountings . . . with many combinations of input and output shaft arrangements.

These shock-absorbing reducers operate smoothly and quietly. Durable and compact, they are unsurpassed for adapting high motor speeds to modern production needs. Power is transmitted at either moderate or slow output speeds with ample capacity for heavy loads.

All types are fan-cooled. An aluminum radial fan directs a steady flow of air over the finned sides of the housing, resulting in cooler operation that pays off in increased hp for each center distance . . . lower initial cost.

Other design features include: automatic splash lubrication, durable centrifugally cast bronze-alloy gears, hardened, ground and polished nickel-steel worms and adequate roller bearings. Single and double lip oil seals ride on micro-finished shafts. High capacity involute helicoid worm threads assure accurate engagement.

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ASK OUR ENGINEERS!

Our experienced field engineers will help you with your application problems. With industry's most complete speed reducer line to work with, their recommendations are unrestricted, unbiased. Contact your nearest Link-Belt office or authorized distributor. Ask for book 2824.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World. 15,591

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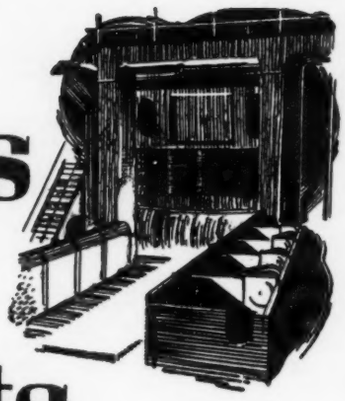
Crops *and* Shorts



△ Business must be better. The steel industry is running at 80.5 per cent instead of its 50 to 55 of the latter months of last year. Of course, we aren't making any more steel. It's just that production is now being compared with a new unfamiliar index which actually represents about 65.5 per cent of 1960 capacity and maybe only 57 per cent of our actual present secret capacity. So if you want to estimate the actual rate of operation, you can multiply 80.5 per cent × 65.5 or 57 per cent, whichever you wish, and come up with 52.7 or 46 per cent.

Percentages are tricky things!

△ Discussing the U.S. secret steel capacity, Metal Bulletin (London) says:

"In fact, it seems to us that the American steel industry has been hyper-sensitive and attempts to conceal how the industry is faring are surely naive, and will probably turn out to be fairly useless. There is little doubt that observers will attempt to estimate capacity and arrive at their own ingot rate, or show clearly in graph form the trend in steel output, and in fact secrecy can only be assured by the utterly retrograde step of not publishing output figures at all."

△ Hung over a telephone in one of our major western steel plants is the following list, which might be useful anywhere:

Table of Excuses

1. That's the way we've always done it.
2. I didn't know you were in a hurry for it.
3. That's not my department.
4. No one told me to go ahead.
5. I'm waiting for an O.K.
6. How did I know this was different?
7. That's his job, not mine.
8. Wait till the boss gets back; ask him.
9. I forgot.
10. I didn't think it was very important.
11. I'm so busy, I just didn't get around to it.
12. I thought I told you.
13. I wasn't hired to do that.
14. First thing in the morning.
15. The hell with it.

△ A study of depreciation allowances in Great Britain, Canada, West Germany, Sweden, France, Italy and Japan, presented by Machinery and Allied Products Institute, shows that in two of these countries the first-year writeoff exceeds 50 per cent of the cost. In two more it exceeds 30 per cent. The corresponding figures of the United States is 13 per cent. Two countries permit a recovery of more than 70 per cent in the first three years of service, and two more allow over 60 per cent. The American equivalent is 35 per cent. Only one country (West Germany) is now in our class, having decelerated its depreciation schedule, after a period of greater liberality, as a brake on what was deemed excessive investment activity.

△ According to the American Iron and Steel Institute, steel companies in the United States spent $1,480,000,000 for new equipment and construction in 1960. This is second only to the 1957 figure of $1,723,000,000. For 1961 the industry plans to spend approximately $1,200,000,000.

△ Have you heard about the nurse who ate an apple every day—but the young doctors still chased her.

And then there was the All-American quarterback who took back his fraternity pin from his girl when he found she was being faithful to the end.

△ Joseph L. Block, chairman of Inland Steel Co., told the Financial Analysts of Philadelphia that the most serious of the industry's problems is competition from foreign steel The best antidote for it can be compounded only with the help of labor leaders.

"We cannot possibly continue to raise our employment costs as we have in the past and expect to win this battle with the overseas steel producers," Block said. "The jobs of American steelworkers are at stake and one would think that the time has come when the responsible labor leaders should face up to this serious fact."

△ Isn't it funny? The fellow who got that order away from you yesterday is a low-down, price-setting so-and-so. When you got that order away from him last month, it was superior salesmanship.

△ Logan T. Johnston, president of Armco Steel Corp. states:

"At Armco, we believe that steel production in the coming months will move considerably above its present level. Although the upturn will be gradual, the first quarter of 1961 should show a definite improvement over the last quarter of 1960 . . Our measured optimism is based on the belief that total steel consumption in 1961 will be at about the same level as in 1960, but steel production will be more closely related to steel usage, resulting in a better balanced quarterly average."

△ We don't know how it is in other kinds of business, but the advertising business is rapidly succumbing to "telephonitis." Never use a letter when there's a phone handy! Even more disturbing is the apparent growing tendency to call collect. It seems some people don't include the cost of phone calls in their own business budget. Several advertising agencies are the worst offenders in our book, seldom writing letters, but placing collect phone calls—even when they want to ask a favor.

Maybe that's why A.T. & T. is doing so well.

△ The Economic Advisory Committee of the National Association of Manufacturers says that foreign competition should be regarded as a challenge rather than a disaster—a challenge to "Show the good sense to do the things we ought to be doing anyway." These things include removing the tax barriers to capital formation, authorizing sound depreciation policies, curbing the monopolistic powers of labor unions and, in general, providing the kind of economic climate which is conducive to business growth and individual freedom.

WESTERN ELECTRIC

rolls billets this small.....and flats this thin.....

on **BIRDSBORO** 18″ two-high Reversing Hot Mill

Birdsboro 18″ reversing hot mill at the Hawthorne Works of Western Electric Co., Inc., Cicero, Ill.

• This Birdsboro mill rolls $1\frac{1}{2}''$ and $2\frac{1}{2}''$ square billets . . . various flats (including one 7″ wide by .375″ thick) . . . from ferrous alloys containing nickel, cobalt and vanadium!

• With all the engineering features of larger blooming mills, it mechanizes many operations formerly done on set pass mills.

• Not all Birdsboro mill machinery is this small. But—small or large—all deliver big advantages. For specifics, please write *Sales Department, Engineering Department and Mfg. Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

MM93-60

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How Empire-Reeves gets better quality steels...faster

Lee Wilson open coil annealing improves uniformity, facilitates delivery, reduces inventory at Empire-Reeves

"Improved customer service," reports Donald W. Frease, President of Empire-Reeves Steel Corporation," is just one of the assets the addition of the Lee Wilson Open Coil Annealing has given Empire."

"We can now process orders with much greater speed," he continues, "yet we can reduce our inventory in the annealing department, because—by opening the coil—hot gases can saturate the entire coil in a fraction of the time previously required. Cool-down is just as efficient.

"The quality of our product is improved because the heat quickly reaches every square inch of the surface of the steel coil. This means it receives a perfectly uniform anneal with an absolute minimum of hardness variation. Because we are handling individual coils instead of continuous strip we have wonderful flexibility. We can process short orders as easily as long runs.

"The Lee Wilson Open Coil Process thus enables us to improve our customer service and our product, and at the same time, gives us the most efficient annealing system available today," Mr. Frease concludes.

If a better product or more efficient annealing department appeals to you, why not get the last word on annealing practice. The Lee Wilson sales engineer in your area will be happy to meet with you at your convenience.

Donald W. Frease, President of Empire-Reeves Steel Corporation (center), tells J. L. Whitten, Vice President of Sales of Lee Wilson (right), and E. G. Fenton of Empire, the results of Open Coil Annealing at Empire after the first few months of operation.

Overall view of the Lee Wilson Open Coil Annealing installation at Empire-Reeves' Mansfield, Ohio, plant.

Lee Wilson® ENGINEERING COMPANY, INC.

20005 LAKE ROAD ★ CLEVELAND 16, OHIO

HIGH PRODUCTION ANNEALING SYSTEMS

MAKE THE BEST METALS BETTER

★ ORIGINATORS AND LEADING PRODUCERS OF OPEN COIL AND SINGLE STACK FURNACES

From raw steel to finished product . . .

McKay Packaged Production Lines help Tex-Tube, Inc. lead the way in the Southwest

The McKay Machine concept of developing completely integrated, packaged production lines is paying dividends for Tex-Tube, Inc., a fast-expanding manufacturer of structural and petroleum tubing of Houston.

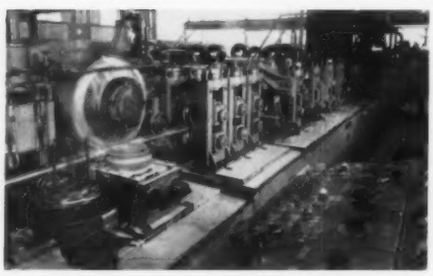
For Tex-Tube, McKay engineered a production unit that will form a complete line of tubing in a wide range of sizes from large multiple width coils.

The McKay production unit consists of a slitting line and two tube mills integrated with a shear welder. Tex-Tube is able to limit inventory only to gauge and type of steel . . . to slit to width desired, form, weld and cut-to-length tubing at a combined rate of 300 fpm in a smooth, continuous operation. They can, on this compact line, form tubing in size ranges from 1″ to 6⅝″ and any wall thickness up to 3/16″.

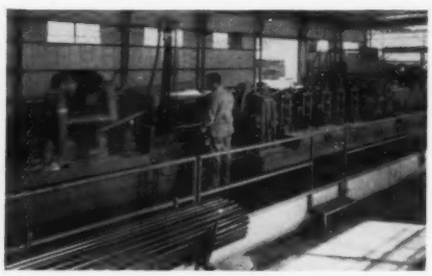
The result: Users of line pipe, oilwell casing and tubing, shothole casing, mechanical and structural tubing are assured quick delivery of highest quality tubing at fair prices.

Whatever you make—if it requires metal handling, feeding, slitting, shearing, stamping, welding or forming—you should know about McKay Packaged Production Lines . . . production equipment engineered to work in unison, with one-source responsibility from start to finish. Write for literature to *The McKay Machine Company, Youngstown 1, Ohio.*

SHEARWELDER—designed and built by Metal Processing Machine Co., subsidiary of McKay—trims tail of one coil and leading edge of second coil, welds them together in perfectly smooth weld while tube mill is running.



TUBE PRODUCTION—Series 700 McKay Mill, one of the two at Tex-Tube—gives Tex-Tube fastest production of top quality welded tubing in the widest variety of sizes.



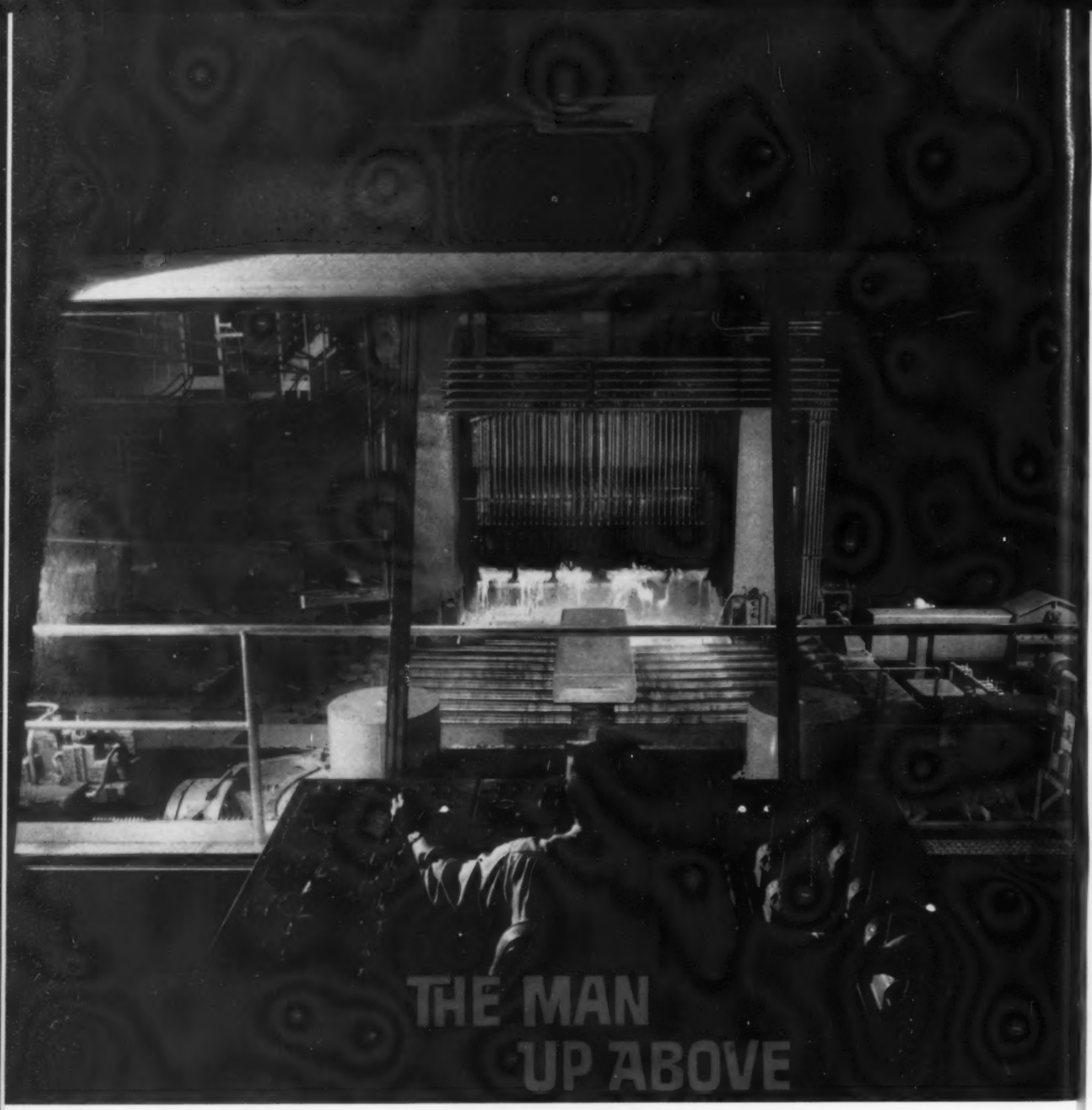
CUTOFF—an integral part of the tube mill, it is a combination saw and rotary head type—cuts to exacting length, feeds onto automatic sizing and inspection table.

LOOK TO

McKAY MCK MACHINE

FOR PROGRESS IN METAL PROCESSING

Charles A. Carter (left), chairman and president, and I. Walker Shaw, vice president, of Tex-Tube, listen as C. W. Thomas, McKay sales manager, points out that even though mill speeds have been increased substantially, the McKay process develops highest possible weld quality.



RUNS THINGS

He pulls a lever. Things happen down below. If he goofs...
profits go out the window.

It pays to keep this man efficient, comfortable,
air conditioned. Write for the facts about a special air conditioner
engineered to perform well in dirty, high heat locations.

More **Sintern** *Aire Rectifiers cool more cabs and pulpits than any other make.*

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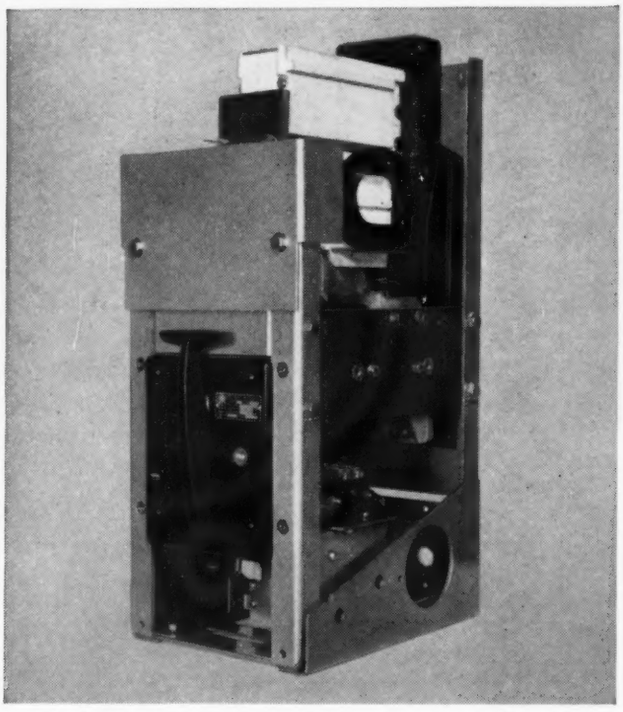
Want an expensive hobby? Keep old d-c circuit breakers in service beyond their time



Model FB d-c circuit breaker, stationary single-pole, with manual stored energy closing.

If you don't have high-speed circuit breakers protecting your d-c circuits right now, you're risking heavy down-time expenses every day. High current faults can damage your generators or rectifiers—shut down your production —chew holes in your profits.

Hanging on to old-design d-c breakers is not sound economy. Even one power interruption could cost you more than the price of a new, modern high-speed I-T-E Model FB circuit breaker. And you can install these breakers without paying a premium over the cost of other makes that do not have the high-speed feature.

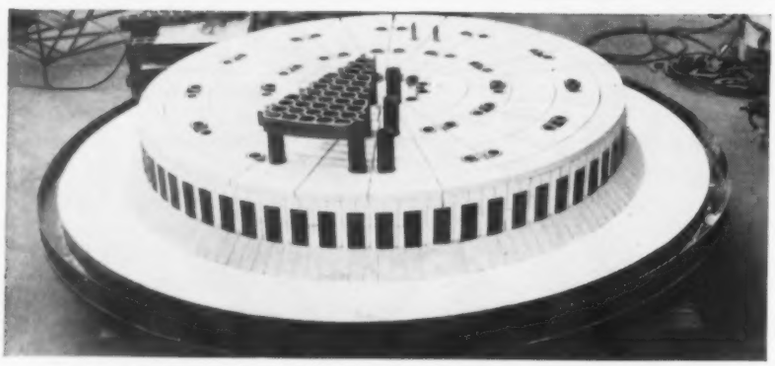
Replace your old breakers now. The truth is that today only this new I-T-E breaker gives you the benefits of the latest knowledge of d-c circuit breaker design. For example:

- Current limiting action within 6 milliseconds
- Applicable on systems with rates of rise of 15 million amp/sec at 1000 volts
- Stored energy closing, manual or electric
- Tilting arc chutes for easy maintenance
- New compactness and lightness for easy installation
- Grounded frame for personnel safety

I-T-E Model FB d-c circuit breakers are available either 1 or 2 pole stationary or drawout and in capacities from 1200 through 12,000 amp continuous. Write for Bulletin 4601-A. I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton St., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY

New Alloy Supertherm* proves itself in 2300 degree fahrenheit brazing furnace



Supertherm hearth grid segment during furnace construction.

In a brazing furnace for the thrust chambers of rocket engines at Rocketdyne Division of North American Aviation, Inc., Canoga Park, Cal., a Supertherm furnace hearth grid assembly is operating at a temperature of 2300° F. The grid in a furnace built by the General Electric Company's Industrial Heating Department at Shelbyville, Ind., supports the engine parts during a brazing cycle of from five to eight hours with a maximum temperature of 2300° F. At this extreme temperature and under severe conditions of thermal fatigue created by the brazing cycle, *the Supertherm grid has performed successfully over one year.*

Supertherm is Electro-Alloys' new alloy for the 1800 to 2300 degree fahrenheit range. The composition of Supertherm is 26% chromium, 35% nickel, and is strengthened and stabilized with cobalt and tungsten. For technical information about the composition, physical and high temperature properties of Supertherm, fill out and return the coupon or contact your local Electro-Alloys representative.

*Supertherm is a patented alloy.

Electro-Alloys Division
3032 Taylor Street, Elyria, Ohio
Please send technical information on SUPERTHERM.

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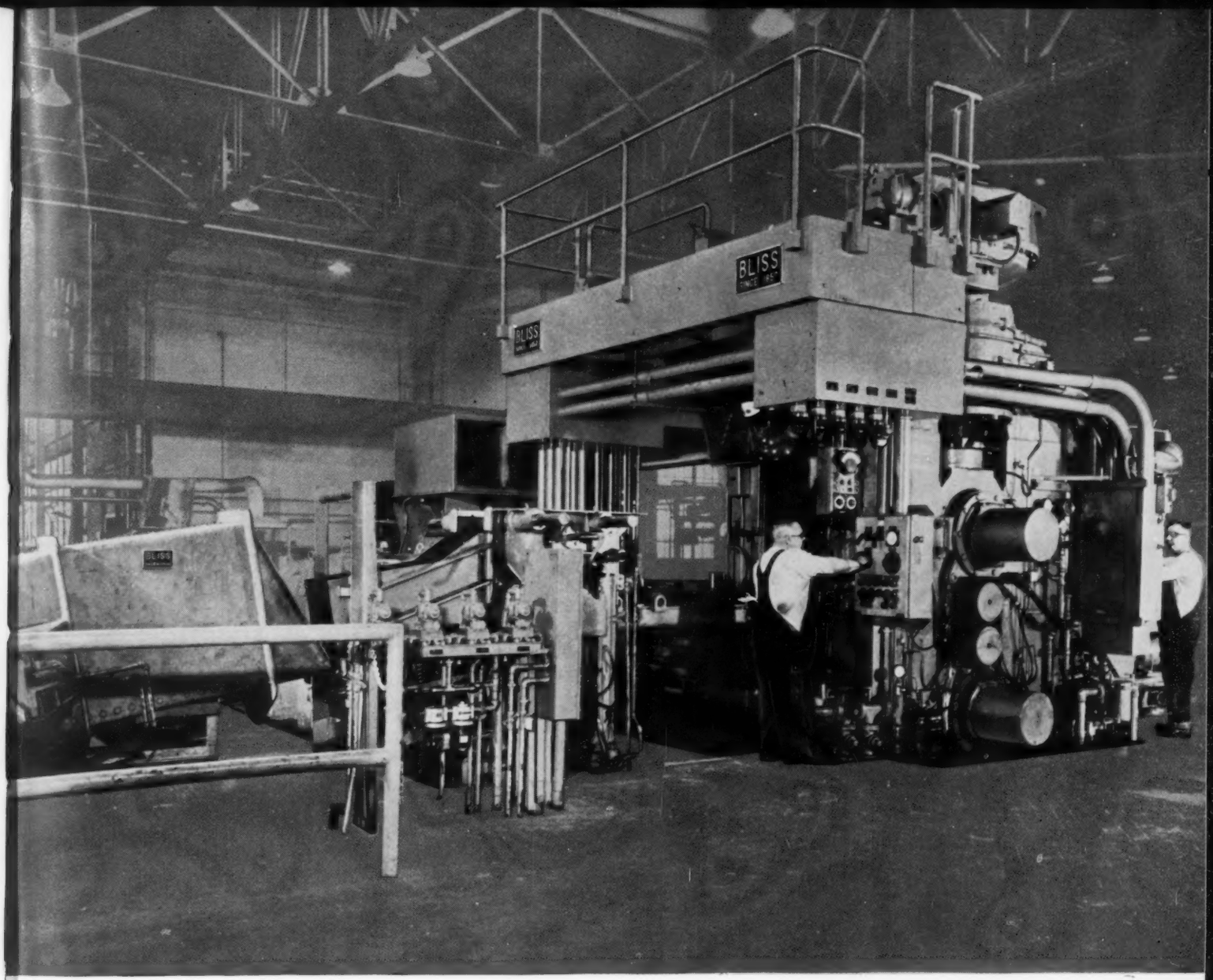

Western Electric feeds a varied diet to its new Bliss cold mill

Each year, about 30 million pounds of metal pass through the new Bliss cold breakdown mill at Western Electric's Hawthorne, Illinois plant. They include both ferrous alloys like Western Electric's Permalloy and a wide variety of non-ferrous materials such as brass, nickel silver and phosphor bronze. No matter what they are, the mill reduces them with ease and precision.

The 12″ and 28″ x 18″ mill is capable of reducing non-ferrous metals from an incoming thickness of .410″ to a finished gauge of .060″ and the special ferrous materials from an incoming thickness of .360″ to a finish gauge of .125″ at speeds up to 300 fpm."

Bliss supplied more than a mill to Western Electric. To meet the customer's particular needs, it designed and built the unique auxiliary equipment, including an inside and outside runaround conveying system, a special turn ender and a specially designed feed unit permitting off-center rolling of narrow material. "Tailoring" mills and equipment to the specific needs of the user is a Bliss specialty. For other examples of this "know-how" in mill design and installations, write for our 84-page Rolling Mill Brochure, Catalog 40-B.

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SINCE 1857

Bliss is more than a name . . . it's a guarantee

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Rolling Mills • Mill Auxiliaries • Amerigear/Bliss Flexible Spindles

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

ELPAR Combines Capacity With Mobility

This rugged Elwell-Parker fork truck handles 8000-pound loads of tin plate with all the maneuverability of a small model at Kaiser's impressive Fontana Works.

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ELPAR trucks are contributing to efficient over-all operations at Kaiser. When *you* have a tough material handling application—let ELPAR carry the load!

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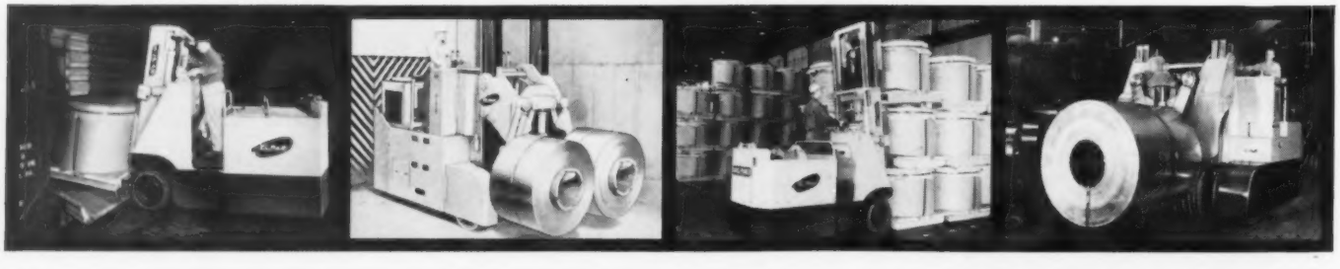
ELPAR—SPECIALISTS IN STEEL MILL TRUCKS



patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period September 16, 1960 to October 11, 1960.

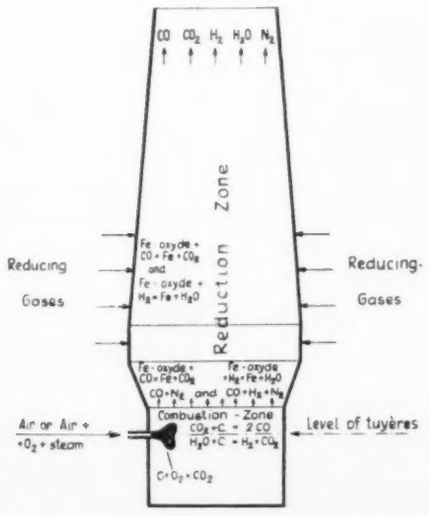
OPERATION OF A BLAST FURNACE

△ U. S. 2,952,533, issued Sept. 13, 1960, to Otwin Cuscoleca, Nils Sjogren and Werner Pichler, provides a method of operating a blast furnace in which reducing gases replace part of the usual solid fuel. The reducing gases are blown into the furnace at such a height above the nozzles which supply the combustion air that free oxygen is not available adjacent to the point of blowing, and the reducing gases are used entirely for reducing the material being treated.

The progress of the reaction in the furnace may be controlled according to the invention, e.g., by the selection or deliberate variation of the temperature of the reducing gases or the like to be blown into the furnace. By an increase in the temperature of the reducing gases to be blown into the furnace, the reaction can be accelerated and by a reduction of the temperature of said fluids the reaction can be retarded.

By the selection of the height of the nozzles for blowing the reducing gases in the shaft, combined with the selection of the temperature at which the gas is blown in, it is possible to cause an arbitrary displacement and at the same time an intensification of the reaction zones in the stack furnace. The method is shown schematically in Figure 1.

Figure 1


CO CO2 H2 H2O N2
Reduction Zone
Reducing Gases
Reducing Gases
Fe-oxyde + CO = Fe + CO2 and Fe-oxyde + H2 = Fe + H2O
Fe-oxyde + CO = Fe + CO2
Fe-oxyde + H2 = Fe + H2O
CO + N2 and CO + H2 + N2
Combustion Zone
CO2 + C = 2 CO
H2O + C = H2 + CO
Air or Air + O2 + steam
Level of tuyères
C + O2 = CO2

HOT TOP CONSTRUCTION

△ U. S. 2,952,055, issued Sept. 13, 1960, to Gordon W. Gottschalk and assigned to Thiem Products, Inc., relates to a hot top construction and more particularly to an improved method of positioning and attaching a wiper strip to a refractory hot top ring.

The present invention is directed to an improved hot top ring structure in which the wiper strip is integrally bonded to the ring. With this construction, the wiper strip is accurately positioned with respect to the ring and will be properly located in the hot top assembly. As the wiper strip is formed integrally with the hot top ring, separate handling of the two members is eliminated and the difficulties involved in the insertion of the wiper strip into the hot top assembly are eliminated. Also, the carrying of a separate inventory of wiper strips for each size of refractory ring is eliminated for the steelmaker using hot top ingot molds.

As shown in Figures 2 and 3, the hot top assembly consists of a cylindrical metal casing 1, provided with an inwardly extending shoulder 2, which supports a refractory lining 3.

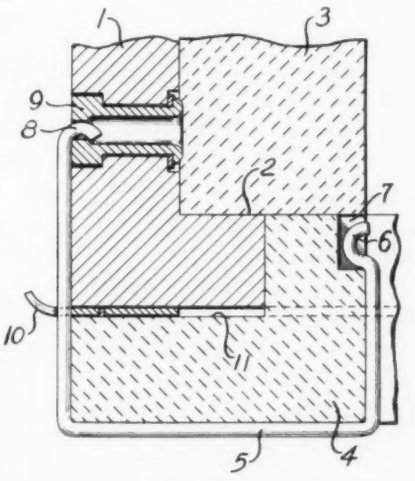
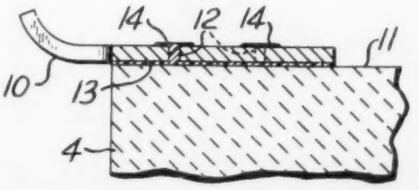


Figure 2

Figure 3



To protect the lower end of the metal casing 1, a refractory ring 4 is secured to the casing by a series of wire clamps 5. One end of each of the wire clamps 5 is provided with a bend 6 which is received within a recess 7 formed in the inner surface of the ring 4. The other end of the wire clamp 5 is provided with a hook 8 which is engaged within a socket 9 formed in the metal casing 1. The spring tension provided by the wire clamps 5 serves to firmly hold the hot top ring 4 in engagement with the lower end of the metal casing 1.

To prevent the molten metal in the ingot mold from passing upwardly between the hot top and the mold, a series of wiper strips 10 are inserted between the metal casing 1 and the upper surface 11 of ring 4.

The inner portion of each of the wiper strips 10 is formed with a series of holes 12 and an adhesive 13 is employed to secure the wiper strips to the upper surface 11 of ring 4. The adhesive is disposed in a layer between the surface 11 and the wiper strip 10 and extends within the openings 12 in the wiper strip. The adhesive mushrooms upwardly within the holes 12 and the crowns 14 are flattened out to provide a generally smooth upper surface for the wiper strip.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

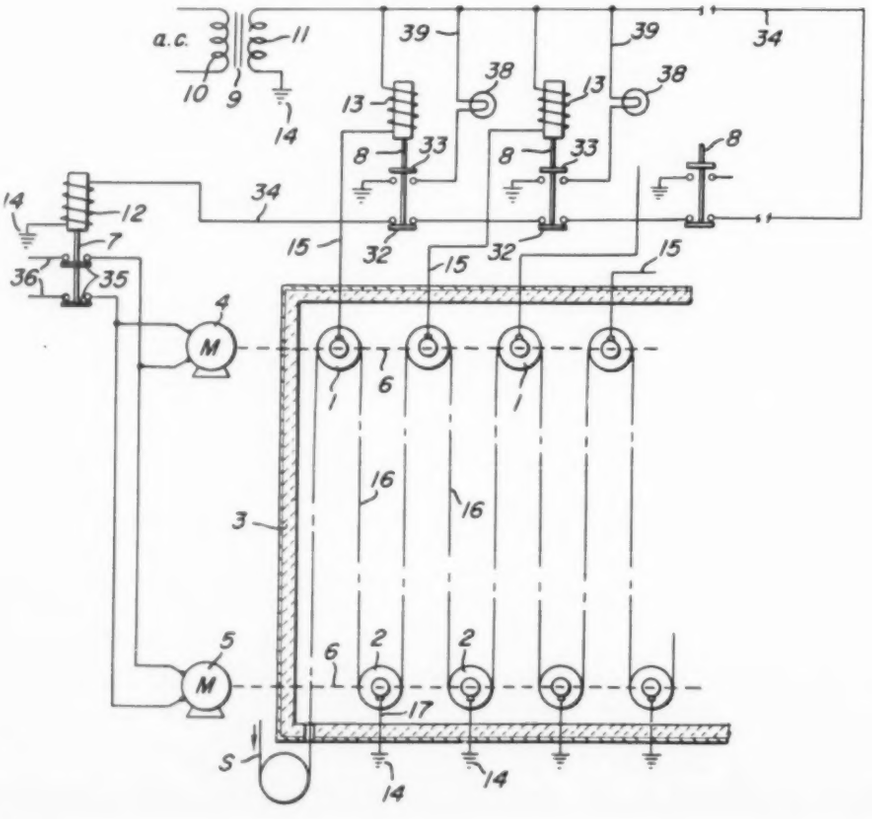
Patent No.	Date	Subject	Inventor or Assignee
2,952,532	9/13/60	Beneficiation of non-magnetic iron oxide ores	American Alcolac Corp.
2,952,534	9/13/60	Cleaning of molten metals	James M. Quinn
2,952,565	9/13/60	Method of coating steel with a water base protecting coating.	Monsanto Chemical Co.
2,952,574	9/13/60	Method of making oil well cable.	United States Steel Corp.
2,952,723	9/13/60	Controlling the atmosphere in an electric furnace	Republic Steel Corp.
2,953,366	9/20/60	Grate bar for pallet of sintering machine	Superior Foundry, Inc.
2,953,794	9/27/60	Forging of pre-warmed metal stock	The Holo-Krome Screw Corp.
2,953,854	9/27/60	Slide caliper with dial indicator and vibrator	United States Steel Corp.
2,954,884	10/4/60	Flexible gas seal for a blast furnace	John Mohr & Sons
2,955,034	10/4/60	Austenitic alloy steel	Union Carbide Corp.
2,955,062	10/4/60	Carburizing in a continuous furnace	Midland Ross Corp.
2,955,334	10/11/60	Continuous casting	Olin Mathieson Chemical Corp.
2,955,709	10/11/60	Hot extrusion of metals	Compagnie du Filage des Metaux et des Joints Curty
2,955,933	10/11/60	Inoculants for cast iron	Union Carbide Corp.

The adhesive penetrates the porous sand composition of the refractory ring 4 and is firmly held to the ring. As the adhesive is disposed within the openings 12 in the strip 10 and is flattened out, as at 14, on the upper surface of the ring, a very firm bond is provided between the wiper strip and the refractory ring 4.

STRIP BREAKAGE DETECTING APPARATUS

△ U. S. 2,952,451, issued Sept. 13, 1960, to William G. Gibbs and assigned to United States Steel Corp., relates to vertical heat treating towers or furnaces of the type used in lines for continuously processing metal strip and, more particularly, to an apparatus shown in Figure 4 for detecting and locating strip breakages in a furnace or tower and for stopping the travel of metal strip in response to a strip breakage.

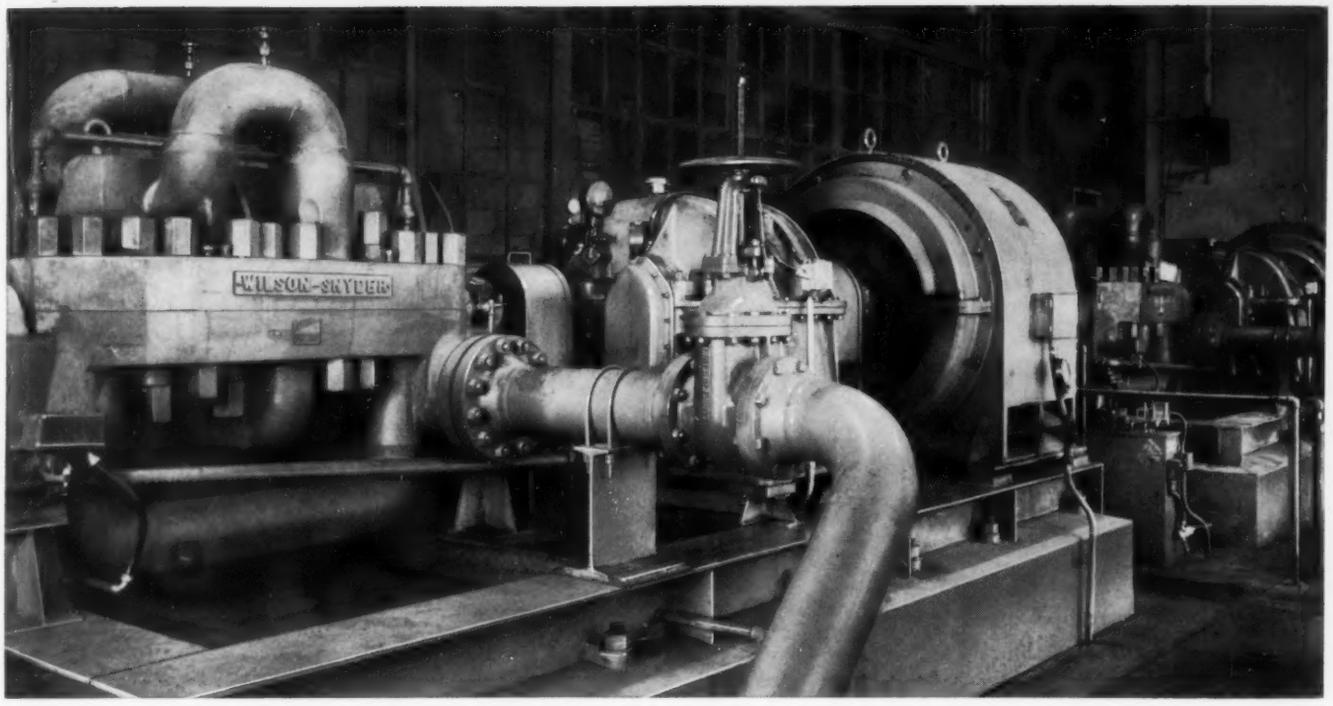
Figure 4



During operation of the furnace, breakage of the strip S at any point within the furnace will open an energizing circuit 15 for one of the relays 8 by interrupting the portion thereof that is normally provided by one of the strip sections 16. When one of the relays 8 drops out in this manner, its contactor 32 moves to open position to interrupt the circuit 34 to the motor relay coil 12, and the motor relay 7 drops out to stop the motors 4 and 5 and thereby further rotation of the conveyor rolls 1 and 2. At the same time, its contactor 33 moves to closed position and operates a signal lamp 38 to indicate the point of strip breakage within the furnace 3. It is apparent that the time required for replacing the furnace in operation can be reduced compared to the time required for the repair of a strip break in conventional arrangements.

PRODUCTION OF COATED METAL WIRE OR STRAPPING

△ U. S. 2,952,561, issued Sept. 13, 1960, to Hobart P. Young and John J. Hickerson, assigned to Signode Steel Strapping Co., provides a



Ford uses Wilson-Snyder High Pressure Descaling Pumps in modernized hot strip mill

Shown above are two Wilson-Snyder heavy duty 6-stage 3,900 RPM centrifugal pumps in Ford Motor Company's modernized hot strip mill. Driven by 2,000 HP, 1,800 RPM motors through speed increasing gears, these powerful pumps deliver water in excess of 1,600 psig to five locations in the mill, two of which have double spray headers top and bottom. This is one of the highest pressure descaling installations in operation anywhere.

Wilson-Snyder also makes complete line of reciprocating pumps

For relatively lower capacities and discharge pressures to 10,000 psi., Wilson-Snyder has a complete line of reciprocating pumps which includes triplex and quintuplex single-acting plunger types, as well as duplex double-acting pumps. These pumps are extensively used in hydraulic system applications and low capacity descaling operations.

Whether you are planning a complete modernization program or new construction, Wilson-Snyder welcomes an opportunity to work with you. We have the engineering "know how" and the experience to save you time and money in selecting and setting up a modern, efficient descaling system. We are prepared to furnish and install the complete system, including the accumulator, charging compressor, headers, strainers, nozzles, spray valves and other necessary components.

We invite your inquiry and will be pleased to quote on your particular requirements. Write or call Wilson-Snyder Works, Oil Well Supply Division, United States Steel, Braddock, Pennsylvania, or your nearest Wilson-Snyder representative.

USS, Wilson-Snyder and Oilwell are registered trademarks

Wilson-Snyder sales engineers . . . at Chicago, Illinois . . . Dallas, Texas . . . Houston, Texas . . . Los Angeles, California . . . New York, N. Y. . . . Tulsa, Oklahoma . . . Pittsburgh, Pa. . . . can furnish you with complete information on this new line . . . or call on your nearest "Oilwell" representative.

This mark tells you a product is made of modern, dependable Steel.

Wilson-Snyder Works
Oil Well Supply
Division of
United States Steel

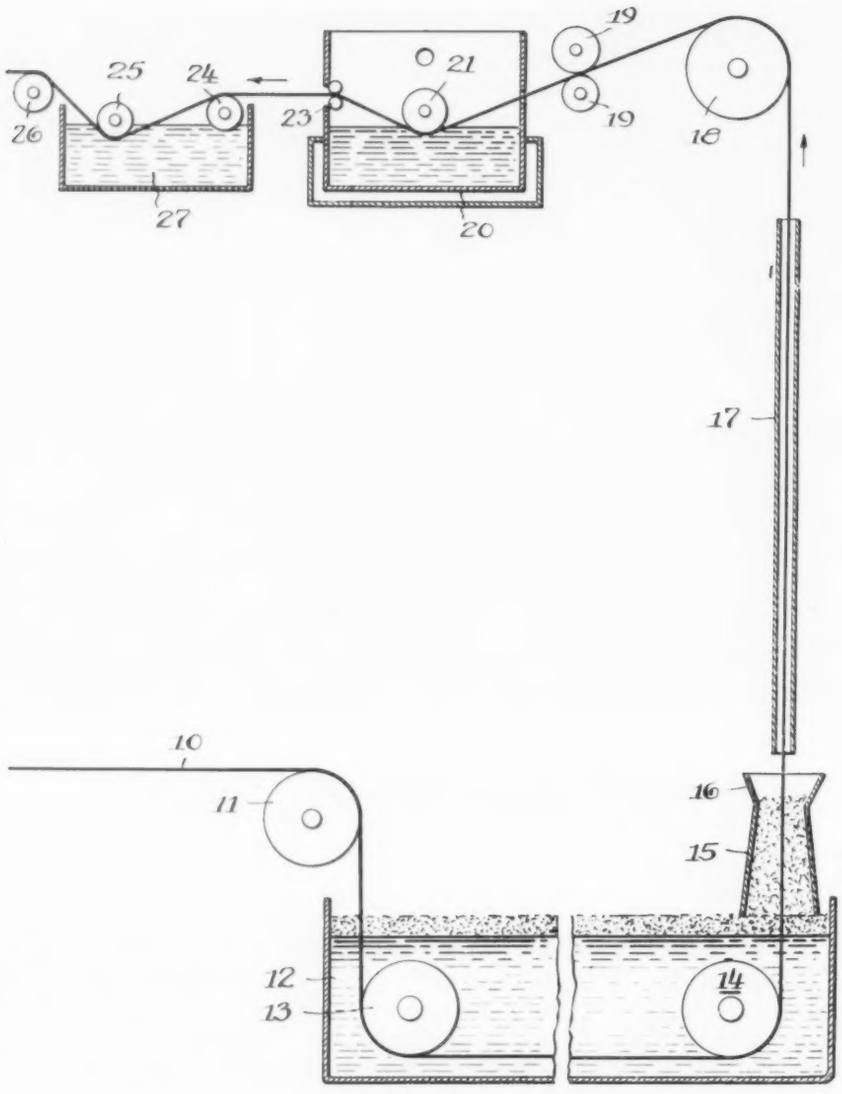


Figure 5

method for preparing coated metal wire or strapping.

The strapping or other tying material is provided with a plastic coating under conditions which permit the coating operation to be conducted as a part of the production and finishing operations in the manufacture of the strapping and without reduction of the speed of movement of the strapping in the production line.

As shown in Figure 5, the strapping entering the processing operation is first subjected to a cleaning operation. Thus, it is guided over a roller 11 and passed through a molten lead bath 12 maintained at a temperature of 750 to 950 F. In this bath a cleaning action takes place, surface adherent material being removed, and in the case of oil or other organic matter, burned away. The strapping is guided through the bath by guide rollers 13 and 14, and emerges through a vertical chute 15 having a funnel shape top 16, which is filled with charcoal. The slow combustion of the charcoal maintains in this chute an atmosphere of carbon monoxide and carbon dioxide and the charcoal also serves to effectively wipe the molten lead from the strapping.

The strapping, after leaving the charcoal chute, passes vertically through a duct 17 in which the surface of the strap becomes blued and is at the same time somewhat cooled. The strap then passes over guide roll 18 and through guide rolls 19, from which it passes into the container 20, in which it is immersed in a molten coating material. In the tank 20 it is forced to pass below the surface of the molten coating material by the action of guide roll 21. The tank 20 is provided with a heating jacket or other suitable heating means and is maintained at a temperature suitable for keeping the coating composition in molten condition and for effecting the coating of the strapping. The composition may suitably be maintained at a temperature of 350 to 560 F and the strapping enters the bath preferably at a somewhat higher temperature.

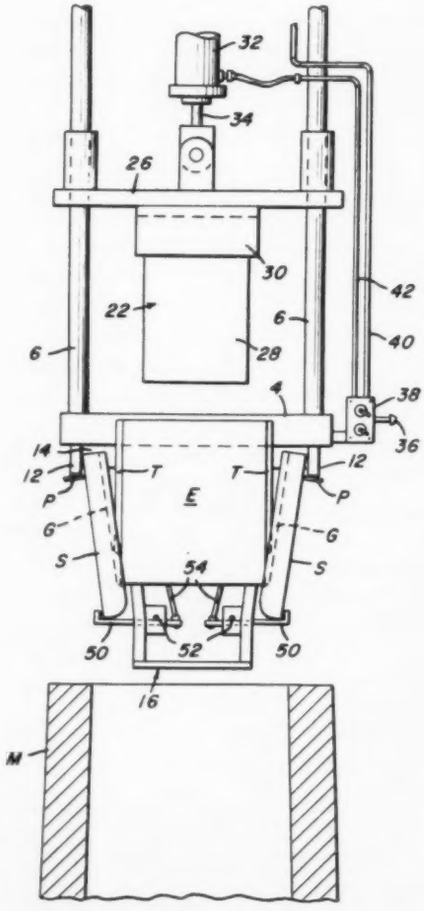
The strapping leaves the tank through wipers 23, which may suitably be tungsten carbide rods or plates, set to secure the desired thickness of coating on the strapping, a suitable thickness of coating being in the range of 0.00005 to 0.00020 in.

After leaving the coating tank 20, the strapping is at once guided by guide rolls 24, 25 and 26 through a cooling or quenching tank 27 containing water at a temperature of 50 to 150 F, and then passes on to conventional reeling machinery, not shown.

APPARATUS FOR SETTING HOT TOPS IN INGOT MOLDS

△ U. S. 2,952,886, issued Sept. 20,

Figure 6



Productioneered Equipment Improves Pickle Line Output

Seven new features developed by Production Machinery engineers and designers are incorporated in this PM Stainless Steel Intermediate Pickling and Annealing Line now in service at Universal Cyclops' Coshocton mill. These developments fit the specific requirement of Universal Cyclops, and result in more profitable operation. Creativity in designing and building equipment to fit the user's needs is the secret of PM "productioneering." We'll be glad to discuss with you the advantages you can get from "productioneered" lines — advantages which generally come as better production, more profits.

Production Machinery Corporation

Mentor, Ohio

Designers and Builders of Metal Processing Lines and Equipment including: lines for pickling, slitting, shearing and cutting-to-length, grinding, scouring, coil build-up, inspection, and other sheet and strip processing lines and machinery.

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ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

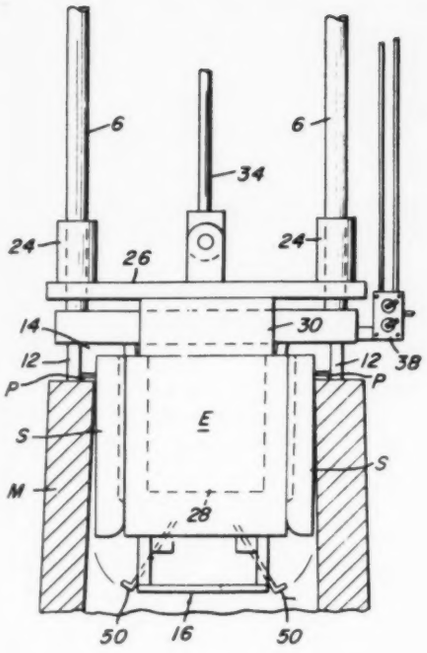


Figure 7

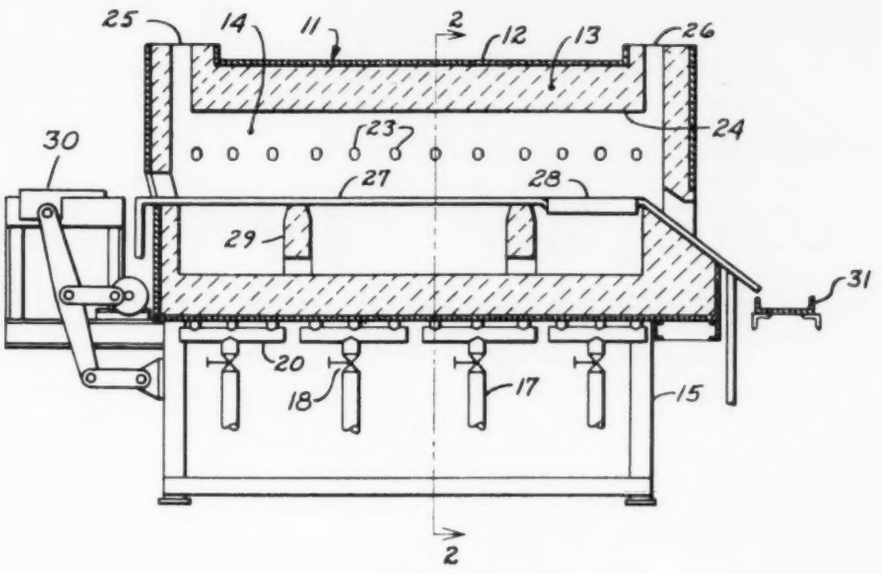


Figure 8

1960, to Arthur G. Mazarakis, and assigned to United States Steel Corp., provides an apparatus for mechanically setting hot tops in ingot molds.

As shown in Figures 6 and 7, the bottoms of side slabs S are placed on the supports 50 with their tops resting against retainer bars 12 and one vertical edge resting against the top bar 14. Tongues T of end slabs E are then placed in grooves G of the side slabs S. The canted position of the side slabs S prevents the end slabs E from falling into place until the device is lowered into mold M to the depth shown in Figure 7. When so lowered, the hinged supports 50 are rotated so that their outer ends move downwardly as shown. This is done by means of valve 38 which controls flow of fluid into hydraulic motors. The end slabs E then slide into position and the upper platen 22 is moved downwardly by fluid flowing through conduit 40 into the top of hydraulic motor 32. This causes the plates 30 to bear against the top of end pieces E forcing them downwardly so as to wedge the slabs S and E into final position against the walls of mold M. A crane then moves the apparatus upwardly out of the mold.

SKID RAIL APPARATUS FOR FURNACES

△ U. S. 2,953,363, issued Sept. 20, 1960, to John D. Nesbitt and assigned to Midland-Ross Corp., pertains to a rail structure which provides an even, insulated surface along which work is conveyed and has particular adaptability to heat treating furnaces.

A typical use of the invention is in connection with a furnace having a high thermal head and utilizing water cooled skid rails for supporting the work passing through the heat treating chamber. As shown in Figures 8 and 9, the high thermal head furnace 11 consists of an outer metal casing 12 and a refractory wall 12. This unit is supported on a stand 15.

A fuel and air mixture is supplied through pipes 17, containing control valves 18, to manifolds 20. Burner pipes 21 carry the mixture from manifolds 20 to burners 22 and then through ports 23 tangentially into chamber 14. This mixture is ignited and spun in the chamber, tending to hug the inner surface 24 of refractory wall 13 which is effectively heated thereby, the work passing through the chamber principally being heated by radiation from this surface. The combusted mixture then travels helically toward flues 25 and 26 where it is expelled.

The work W, which may be billets that are to be forged upon emerging from the furnace, is supported on water cooled rails or pipes 27 which, in turn, are upheld by refractory members 29. Toward the discharge end of the furnace, a soaking zone is maintained with alloy sleeves 28 placed about these portions of pipes 27. To provide an even, continuous surface, the pipes are offset sufficiently to assure that the surfaces of the alloy sleeves 28 are even with the bare portion of pipes 27.

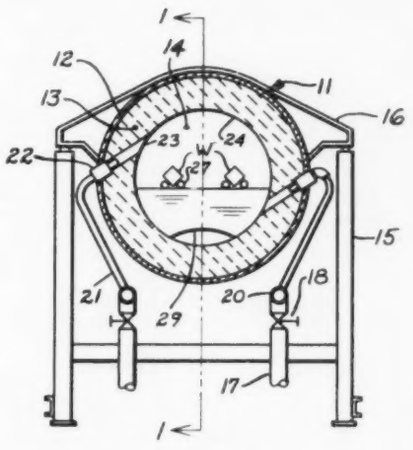


Figure 9

The billets, traveling on the water cooled rails, develop cold spots in the portions adjacent the rails. To allow the temperature within the billet to become more uniform, the alloy sleeves 28 are placed about the water cooled rail 27. In a furnace chamber of 2700 F, these sleeves have a temperature of more than 1600 F compared with a temperature of bare rails 27 of 150 to 200 F. This temperature increase is generally sufficient to prevent excessive eccentricity in the final product.

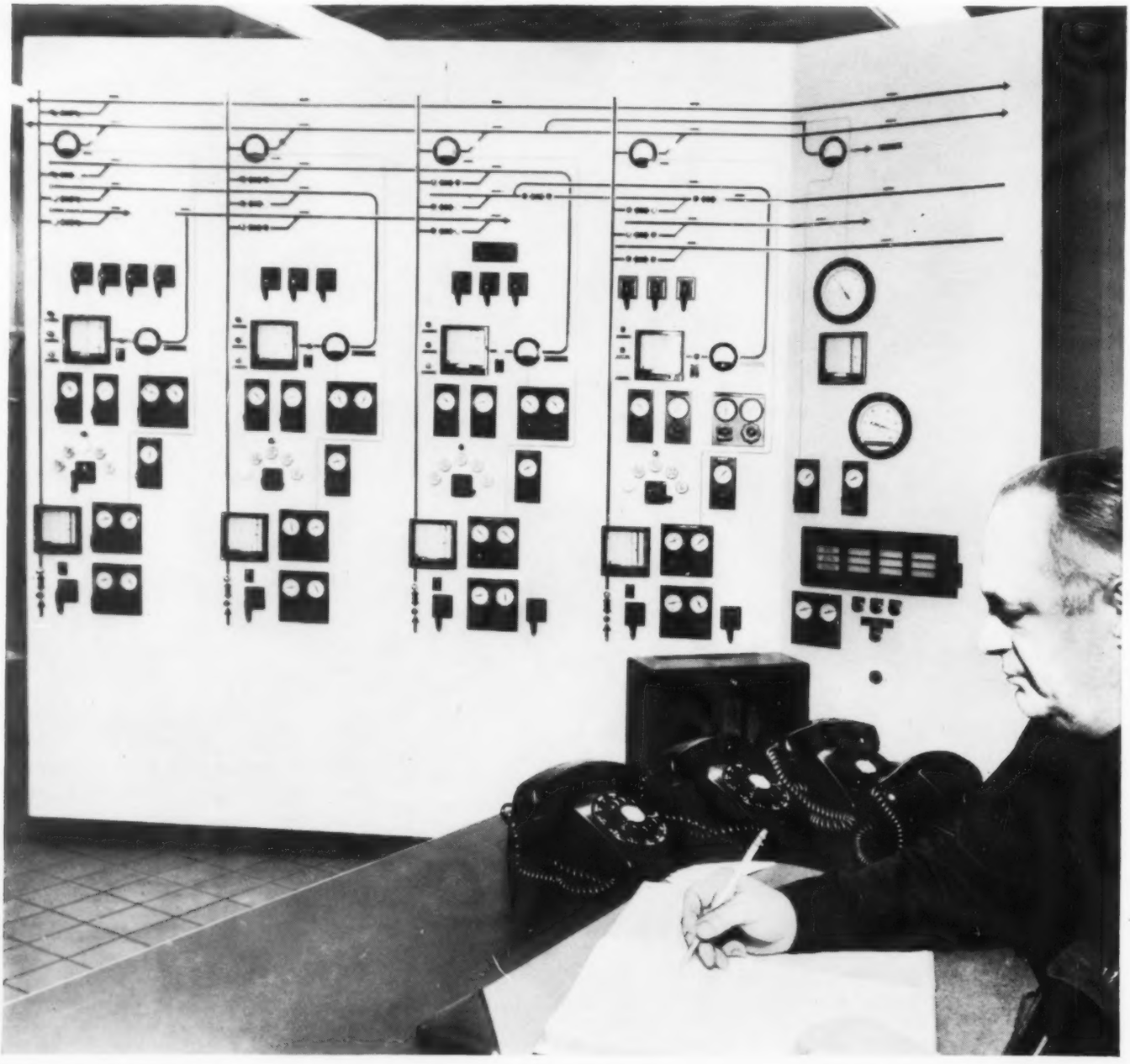
MOVABLE SEALING DEVICE FOR OXYGEN CONVERTERS

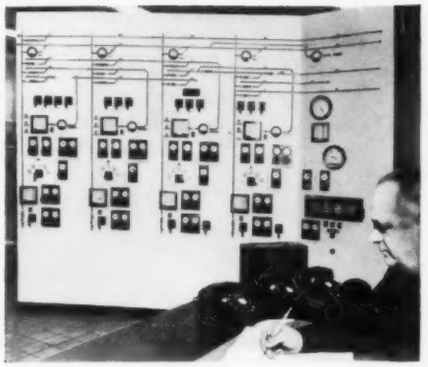
△ U. S. 2,954,244, issued Sept. 27, 1960, to Chester R. Austin and assigned to Henry J. Kaiser Co., provides a movable sealing device or

At U.S. Steel's Gary Works . . .

LOWER BLAST FURNACE BLOWING COSTS WITH HAGAN SPLIT-WIND CONTROL

Designed for future expansion, the graphic control panel is programmed in this manner: ■ No. 4 Turbo is blowing Furnace No. 11. Its excess capacity is "spilling-over" to augment the wind from No. 2 Turbo. ■ No. 2 Turbo is blowing Furnace Nos. 9 and 12, with the additional wind from the "spill-header." ■ No. 6 Turbo is blowing No. 10 Furnace.





Today, split-wind blowing makes it possible for existing turbo-blower capacity to meet the constantly increasing wind requirements of rebuilt, enlarged blast furnaces and to do this at maximum possible efficiency.

A control system, to accomplish this objective, must provide centralized control for operator economy, and the flexibility needed to achieve high blowing efficiencies regardless of varying flow and pressure requirements.

In the system shown, installed at the Gary Works of U.S. Steel, three blowers supply blast air to four furnaces, with a fourth blower on operating standby. Normally, one turbo blows the furnace requiring the highest blast pressure. Excess wind passes into a spill-header and is used to augment the wind from the other active blowers.

The graphic control panel makes true centralized control possible by performing the following functions: shows the position of all control and shut-off valves—indicates and records the flow and pressure to each furnace—shows configuration of manifolding to blow the furnaces—provides communications between the control room and the cast house floor—records and indicates flow and pressure of each blower—provides remote manual operation of the shut-off valves—gives operators a means of changing furnace flow set point and manifold pressure.

For more information, write for Bulletin "Hagan Blast Furnace Control Systems."

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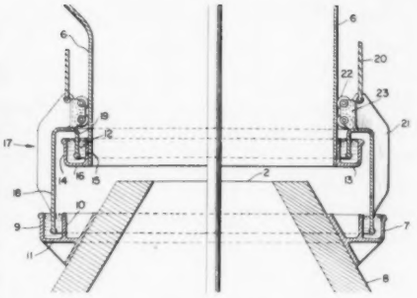


Figure 10

hood for collecting fumes from an oxygen converter.

As shown in Figure 10, the sealing member 17 is lowered into sealing position so that the outer wall 18 engages the sealing medium 12 in the annular channel 7 and the inner wall 19 engages the sealing medium in the annual trough 13. The sealing media may be a liquid, such as water or molten metal, or a solid, such as sand.

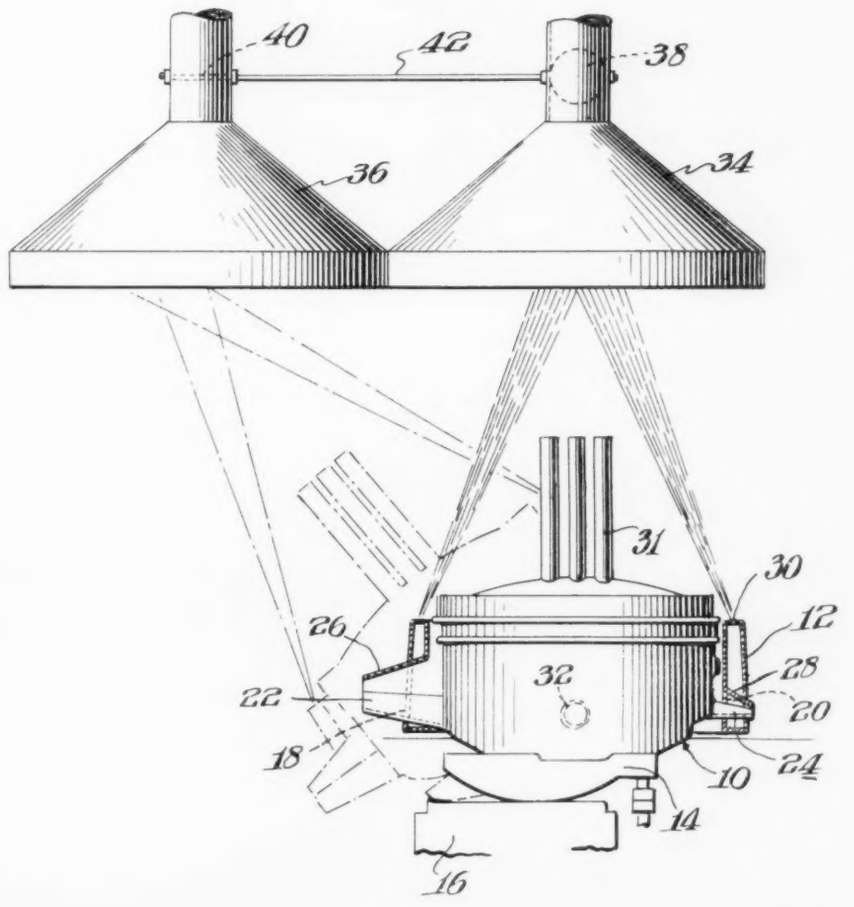
FLUID BARRIER FOR FUMES

△ U. S. 2,954,968, issued Oct. 4, 1960, to Walter O. Vedder, assigned to Pangborn Corp., provides a fluid barrier for fumes, for use in the collection of fumes and dust from electric furnaces and the like.

Figure 11 shows an electric furnace 10 surrounded by a fluid distributing manifold 12. Manifold 12 is attached to the body of furnace 10 so that it may move with the furnace when it is tilted for pouring as shown in phantom outline. The entire furnace is tilted on its curved base 14 which rests on a pedestal 16. Apertures 18 and 20 are provided in manifold 12 through which pouring spout 22 and slag spout 24 extend respectively. Covers 26 and 28 respectively cover pouring spout 22 and slag spout 24 to direct their fumes within the periphery of manifold 12.

A fluid discharge means is provided at the upper portion of manifold 12. This discharge means consists of a series of spaced orifices 30 in the top wall of the manifold. Orifices are defined by inwardly-inclined walls in order to direct the curtain and entrained fumes and dust into a concentrated area to facilitate their collection and removal. This angular curtain clears

Figure 11



the top of the furnace 10 and encompasses electrodes 31 on the roof of furnace 10.

A supply of fluid is conducted to manifold 12 by piping 32 connected, for example, at diametrically opposed sections of the manifold. This assures an even distribution of fluid throughout.

A suction means for the fluid curtain emitted from inwardly-inclined nozzles 30 is provided by dual exhaust hoods 34 and 36. Exhaust hood 34 is positioned directly over the electric furnace in its normal upright condition, and exhaust hood 36 is positioned in the path of the fluid barrier or curtain emitted from nozzle 30 when the furnace is tilted into its pouring position.

ORE BENEFICIATION

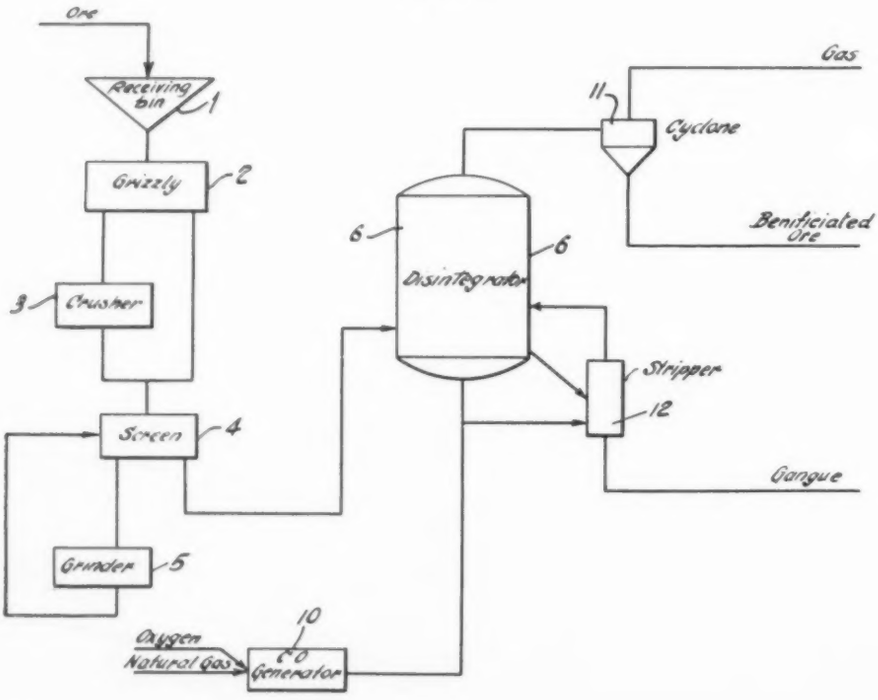
△ U. S. 2,954,288, issued Sept. 27, 1960, to Harold V. Atwell and assigned to Texaco, Inc., describes a method of beneficiation of an iron oxide ore by treatment with carbon monoxide under conditions such as to effect disintegration of the ore and separation of the disintegrated ore into various fractions.

As shown in Figure 12, raw ore from an external source is received in bin 1. The raw ore is subjected to a preliminary size classification in grizzly 2 and the large lumps separated by the grizzly are passed to crusher 3. The fine material from the grizzly and the product of the crusher are combined and passed to screen 4 to separate a fraction finer than about 40 mesh and a coarse fraction. The coarse fraction is passed to grinder 5 and the product returned to the screen 4 so that all material is ultimately ground to pass the 40 mesh screen. The fine fraction comprising ore having a particle size less than about 40 mesh is fed to disintegrator 6. Oxygen and natural gas are converted to synthesis gas containing about 2 mols of hydrogen and one mol of carbon monoxide in carbon monoxide generator 10. The partial combustion reaction which is effected in generator 10 produces a temperature therein within the range of 2400 to 2800 F. The carbon monoxide-containing gas is passed into a lower portion of disintegrator 6 to supply heat to maintain the temperature therein within the range of 650 to 1000 F as well as to provide the desired atmosphere containing carbon monoxide. Disintegration of the metal component of the ore is effected without materially affecting the particle size of the gangue. By virtue of the resulting difference in particle size, the relatively fine metal components are elutriated from the fluidized bed by entrainment in the fluidizing gas and are withdrawn from an upper portion of disintegrator 6 in a stream of the gas. The gas and suspended solids are passed to a cyclone separator 11 to separate the gas from the beneficiated ore, to permit further processing of the ore. Coarse gangue particles are continuously withdrawn from a lower portion of the disintegrator to a stripper or elutriator 12. In stripper 12 the coarse particles are passed in countercurrent contact with a stream of stripping gas which may be a portion of the carbon monoxide-containing gas produced in generator 10 so that only coarse particles of gangue are withdrawn from stripper 12 and fine particles containing metal components are separated and entrained in the stripping gas and returned together to the disintegrator vessel.

RECOVERY OF VALUES FROM NICKEL-BEARING IRON ORES

△ U. S. 2,953,451, issued Sept. 20, 1960, to Marvin J. Udy and Murray C. Udy, assigned to Strategic-Udy Metallurgical & Chemical Processes, Ltd., provides a process for the production and recovery of separate valuable commercial products consisting of ferronickel, iron and ferrochromium from relatively low-grade nickel-bearing iron ores, laterites, nickel-bearing serpentines and other nickel-bearing silicates.

Figure 12



GAGE-CONTROL SYSTEM FOR MULTI-STAND STRIP MILL

△ U. S. 2,949,799, issued Aug. 23, 1960, to Nate S. Walker and assigned to United States Steel Corp., provides a gage-control system for the motors individually driving the several stands of a strip mill.

The invention provides a system for adjusting the speeds of the motors driving the several stands of a mill to correct gage variations by altering the tension on the strip between stands as it is being rolled.

USE THE ENGINEERING MART— THE COST OF AN AD ONE COLUMN IN. IS $10.00 PER INSERTION

FURNACES AND HEATING EQUIPMENT

General view of two galvanizing lines constructed for S.A. Phenix Works at Flemalle-Haute (Belgium).

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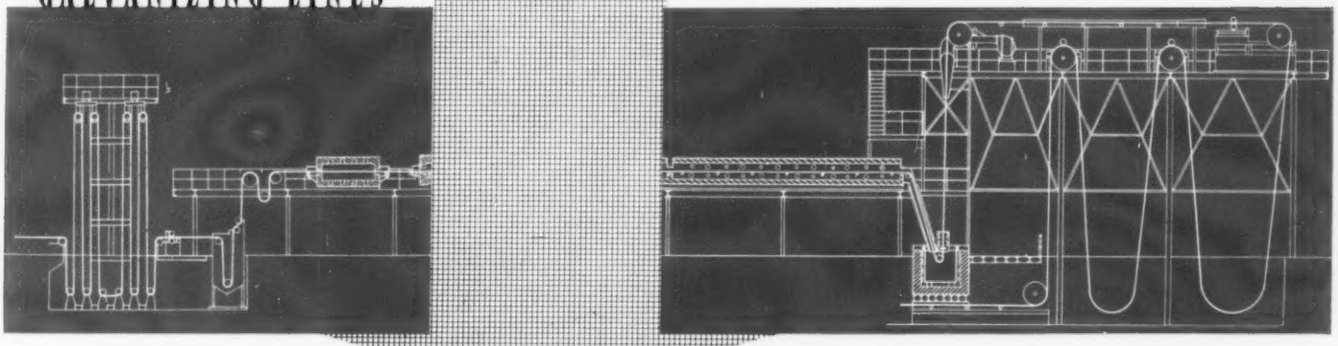
HEURTEY - SENDZIMIR CONTINUOUS WIDE STRIP GALVANIZING LINES



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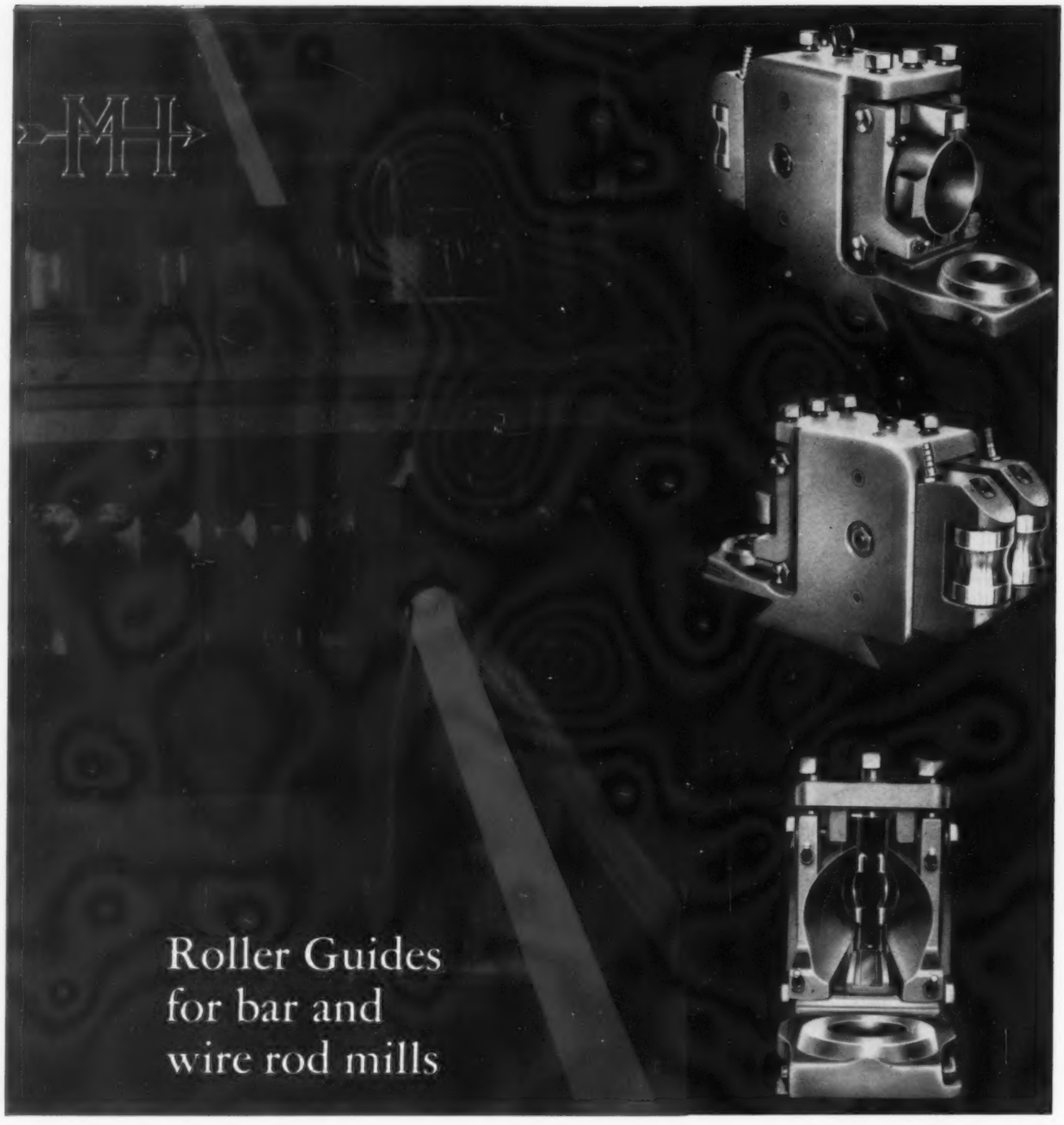

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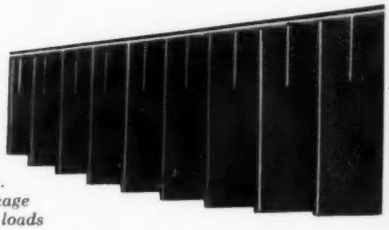

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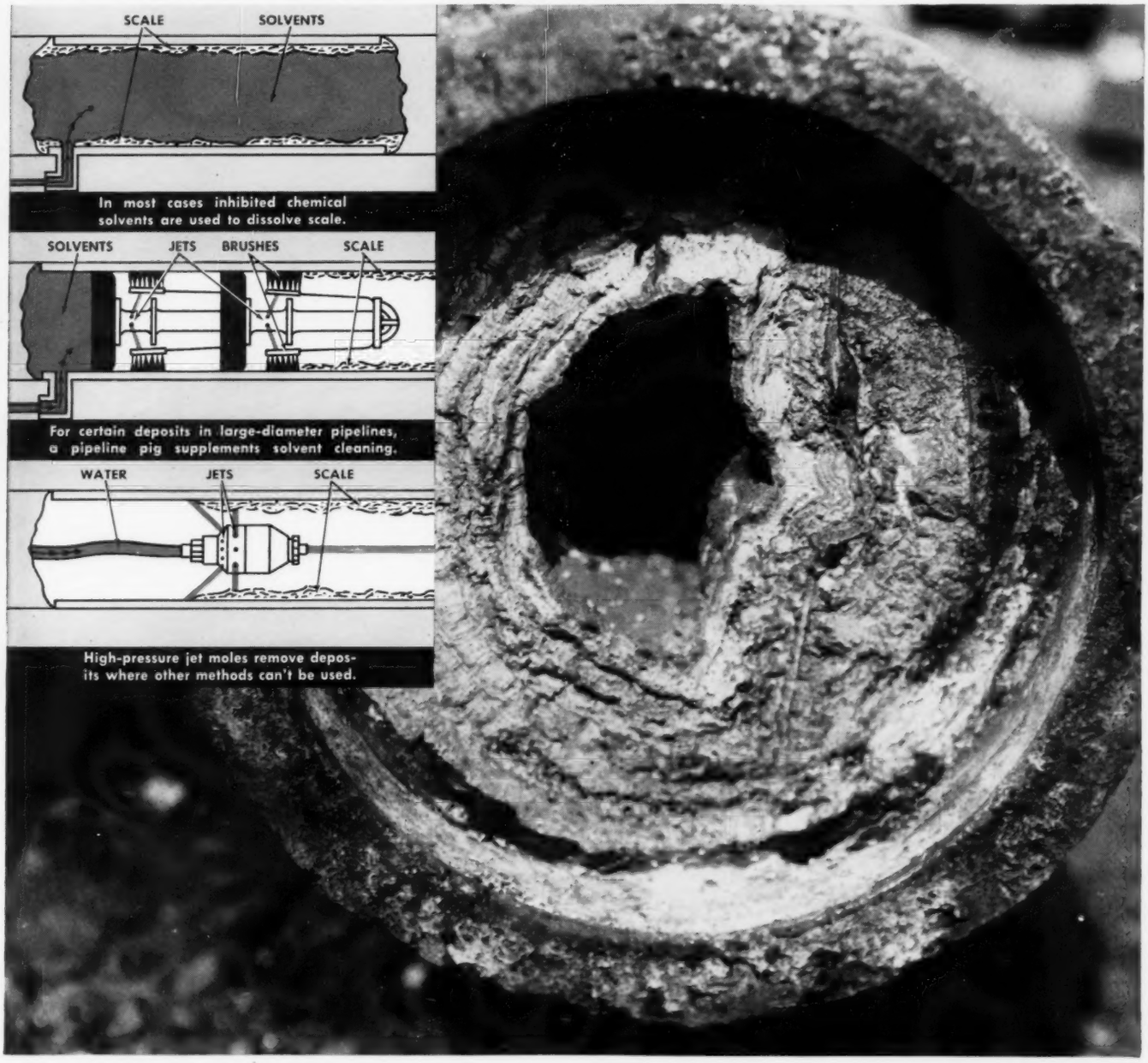

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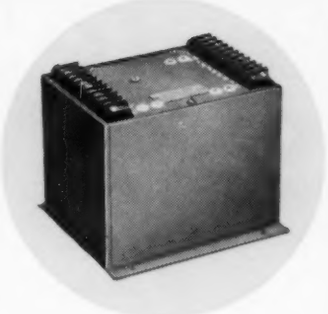

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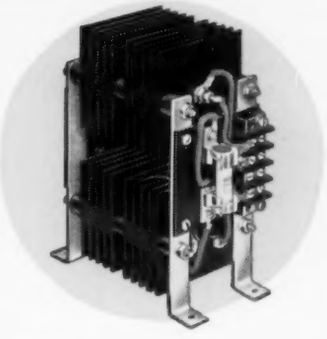

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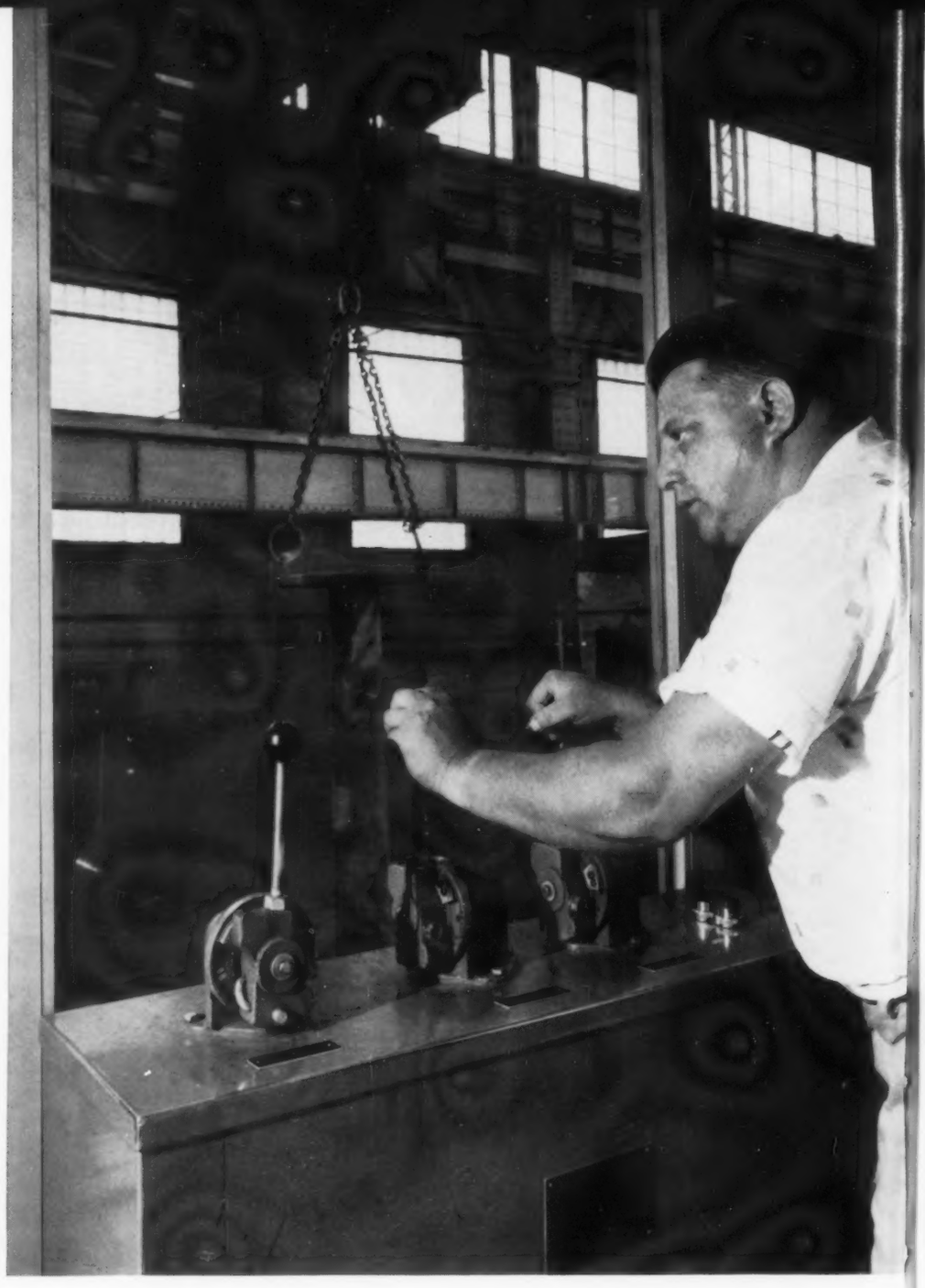
Andy Brinkos is operating an overhead crane



Andy is an Operator—Furnace and Crane, at Midvale-Heppenstall Company in Philadelphia. From his station on the furnace platform he controls and inspects furnace gauges and operates the complete melt when the furnace is in operation.

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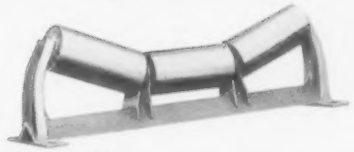

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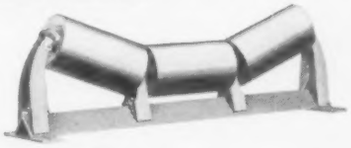

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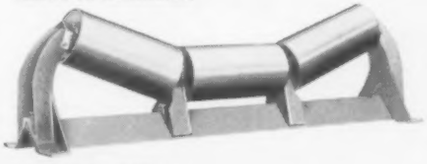

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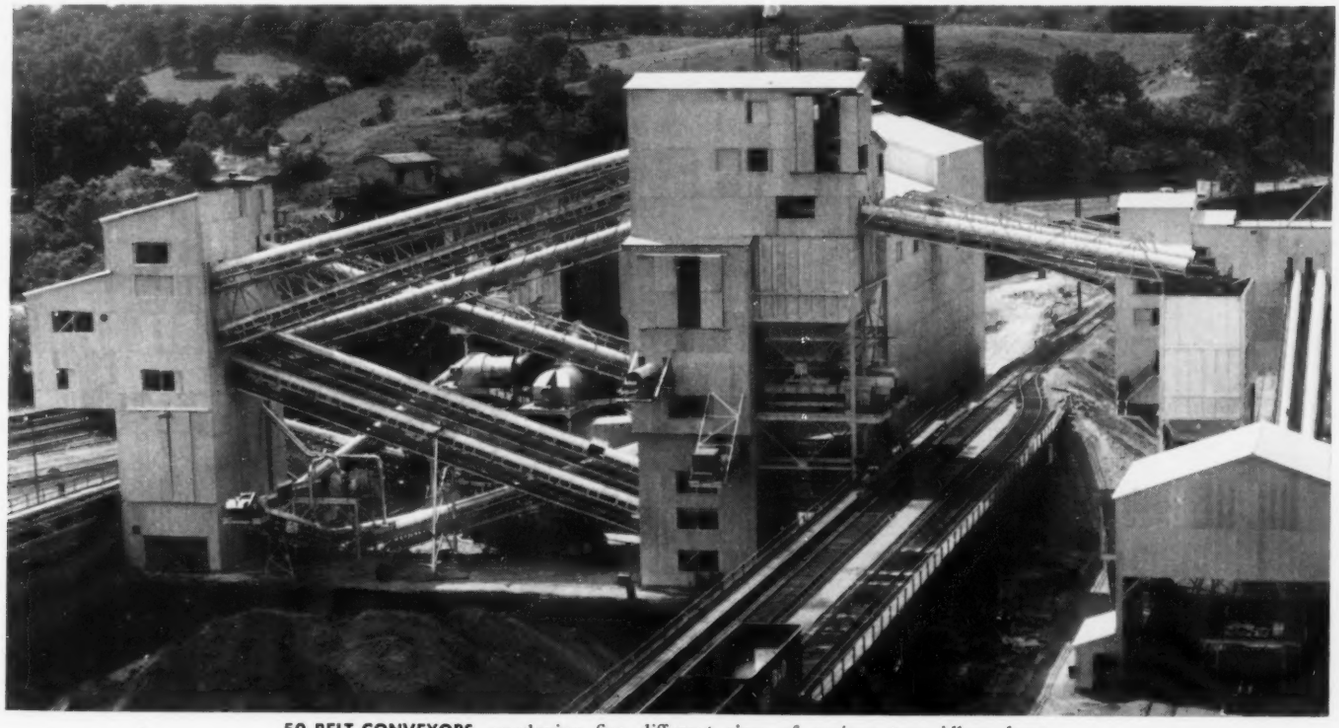

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Now...roll-grinding precision never before possible!

Now from Farrel . . . the most revolutionary roll-grinding improvement in twenty years! Precision-controlled roll grinding has been made possible through a new, patented, trunnion-tilt, pivoted infeed system.

In previous designs, friction resulting from the sliding of the wheelhead on the ways, caused a "stick-slip" phenomenon. With the new Farrel design, the wheelhead is tilted into the work by means of the same support and leverage system that makes Farrel crowning the most accurate you can get. Since the system is always preloaded in one direction, positive infeed and withdrawal of the grinding wheel can be done with great accuracy.

For manual operation, the infeed handwheel is now graduated to .0001". A control stop enables the operator to withdraw the wheel any amount desired, then infeed it again to precisely its previous position . . . smoothly and without backlash. Because of the instantaneous response to this system, optional automatic wheel feed offers highest grinding efficiency.

The precision feed regulator is now a standard feature of all Farrel heavy-duty roll grinders in the 36" to 72" sizes. Write for a quotation on a machine to meet your requirements.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

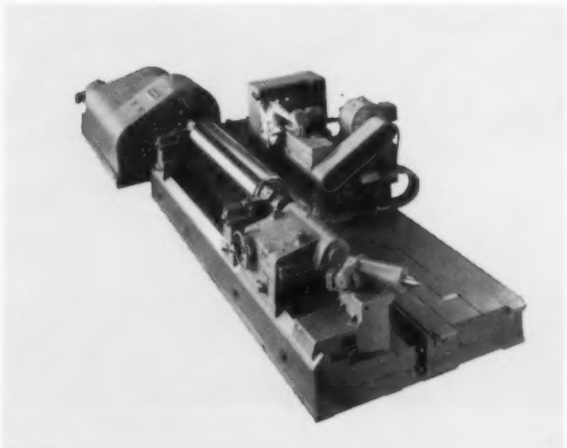
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.

Sales Offices: Ansonia, Buffalo, Akron, Chicago, Los Angeles, Houston, Atlanta

European Office: Piazza della Republica 32, Milano, Italy

FARREL®

60" Farrel roll grinder equipped with new infeed system.



FB-1195

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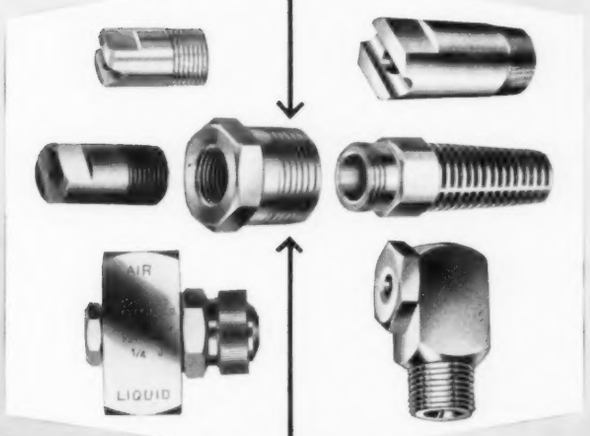
SPRAY NOZZLE
design

TO IMPROVE SUCH SPRAYING OPERATIONS AS

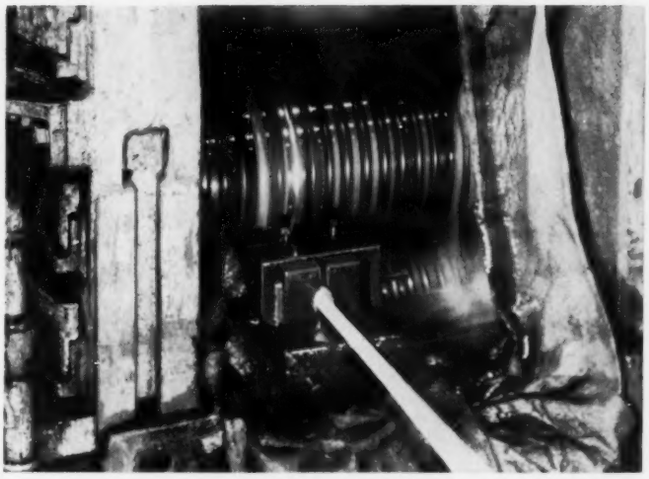
• DESCALING • OXYGEN PROCESS GAS COOLING • PIG—INGOT MOLD—SLAB AND HOT STRIP COOLING • ROLL COOLING • COOLING OPEN HEARTH REGENERATORS • LUBRICANT SPRAYING • BLAST FURNACE GAS WASHING AND COOLING

Whatever the application you will find Spraying Systems Spray Nozzles provide noticeable improvement in spraying operations . . and often materially lower cost. Proved by performance. Supplied in a complete choice of types and capacities for selection of spray characteristics exactly as needed. Your inquiry is cordially invited.



SPRAYING SYSTEMS CO.
3262 Randolph Street • Bellwood, Illinois

For complete information write for Catalog 24 and special data sheet folder "Steel Mill Applications".



Near-white-hot rod enters roller guide housing, and forming rolls beyond. Colmonoy hard surfacing rebuilds worn guides, gives them longer life than before.

Colmonoy Cuts Roller Guide Reclamation Cost

Hard-surfacing alloys that are easy to apply save welding time. And it follows that finishing time is also reduced—easy-applying alloys produce smoother deposits. Time is money, and the maintenance department of a large stainless steel bar mill saves money by using Colmonoy No. 6 alloy to reclaim worn roller guides. With Colmonoy they reclaim three guides in the time it took to do one previously.

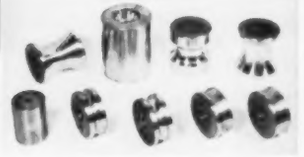
The superior wear-resistance of Colmonoy No. 6 added more savings by extending even further the service life of the guides. All roller guides in this plant are reclaimed with Colmonoy—again and again, indefinitely.

Colmonoy alloys are being used in many mill operations: on plate guides, edger rolls, journal sleeves, and coolant-pump parts. Write for complete information.

Smoothness is the notable characteristic of these Colmonoy-protected guides prior to finishing.

Roller guide being overlaid with Colmonoy No. 6 rod. Work rotation is operator controlled.

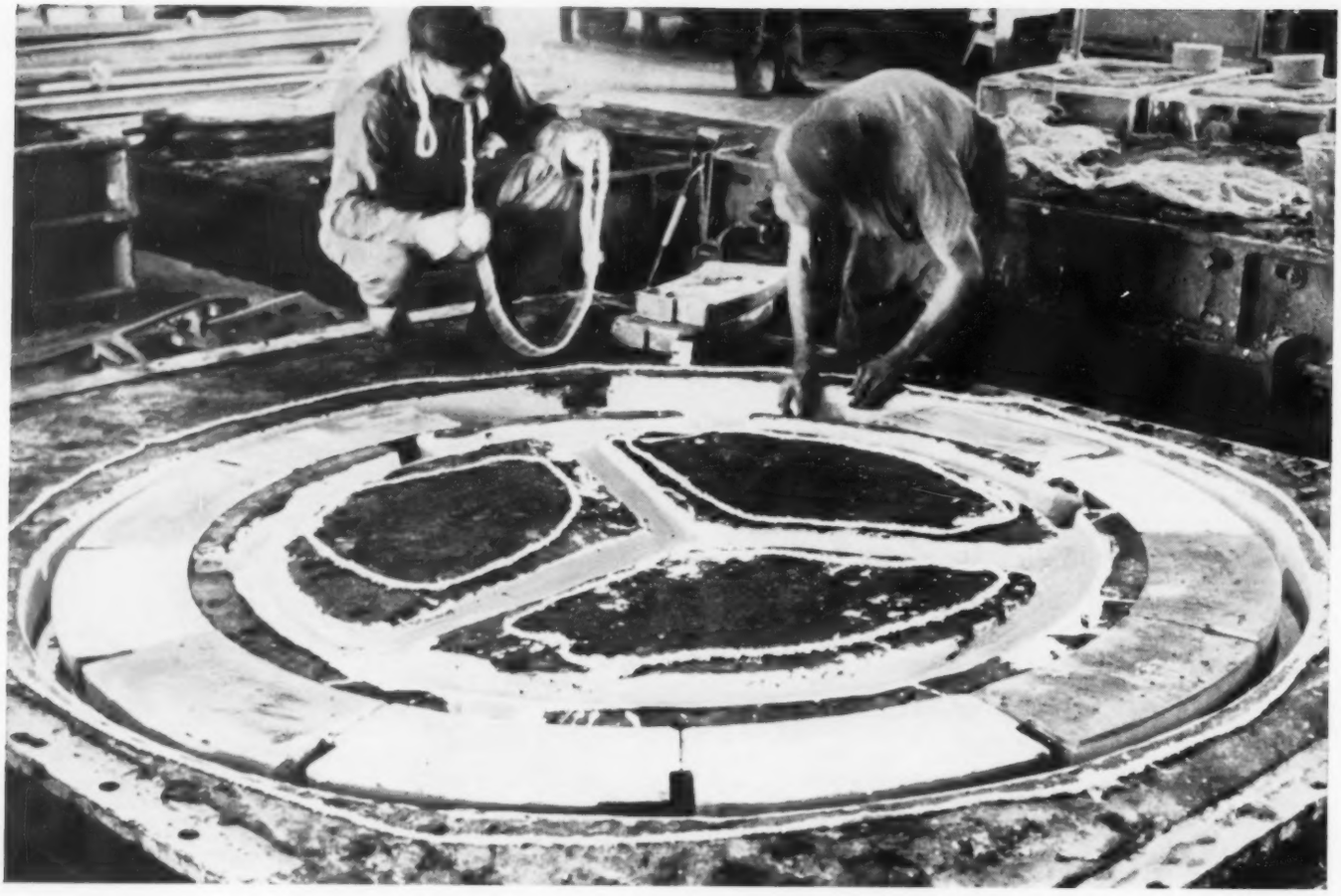
Ready for further service are these finished guides with mirror-bright Colmonoy surfaces.



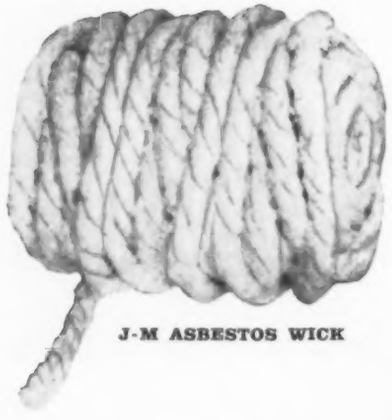
HARD-SURFACING & BRAZING ALLOYS

WALL COLMONOY CORPORATION
19345 JOHN R STREET • DETROIT 3, MICHIGAN

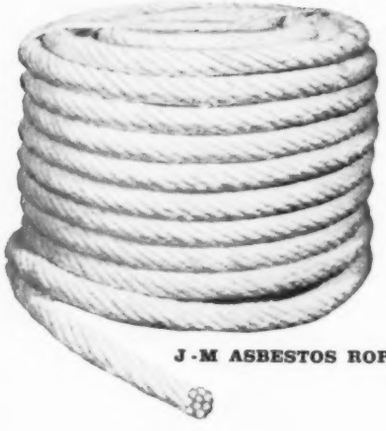
Buffalo • Chicago • Houston • Los Angeles • Morrisville • New York • Pittsburgh • Montreal • London, England



Two quality materials with hundreds of caulking and sealing uses!



J-M ASBESTOS WICK



J-M ASBESTOS ROPE

Whether you are sealing a sand mould or need an emergency caulking, you can rely on these versatile materials. They are easily handled . . . are soft and compressible, conforming readily to surface irregularities for secure sealing even on worn moulds or bases. Made of 98/99% pure asbestos, they withstand high temperatures.

Their many other all-'round plant uses make Asbestos Wick and Rope virtually indispensable throughout industry. For example:

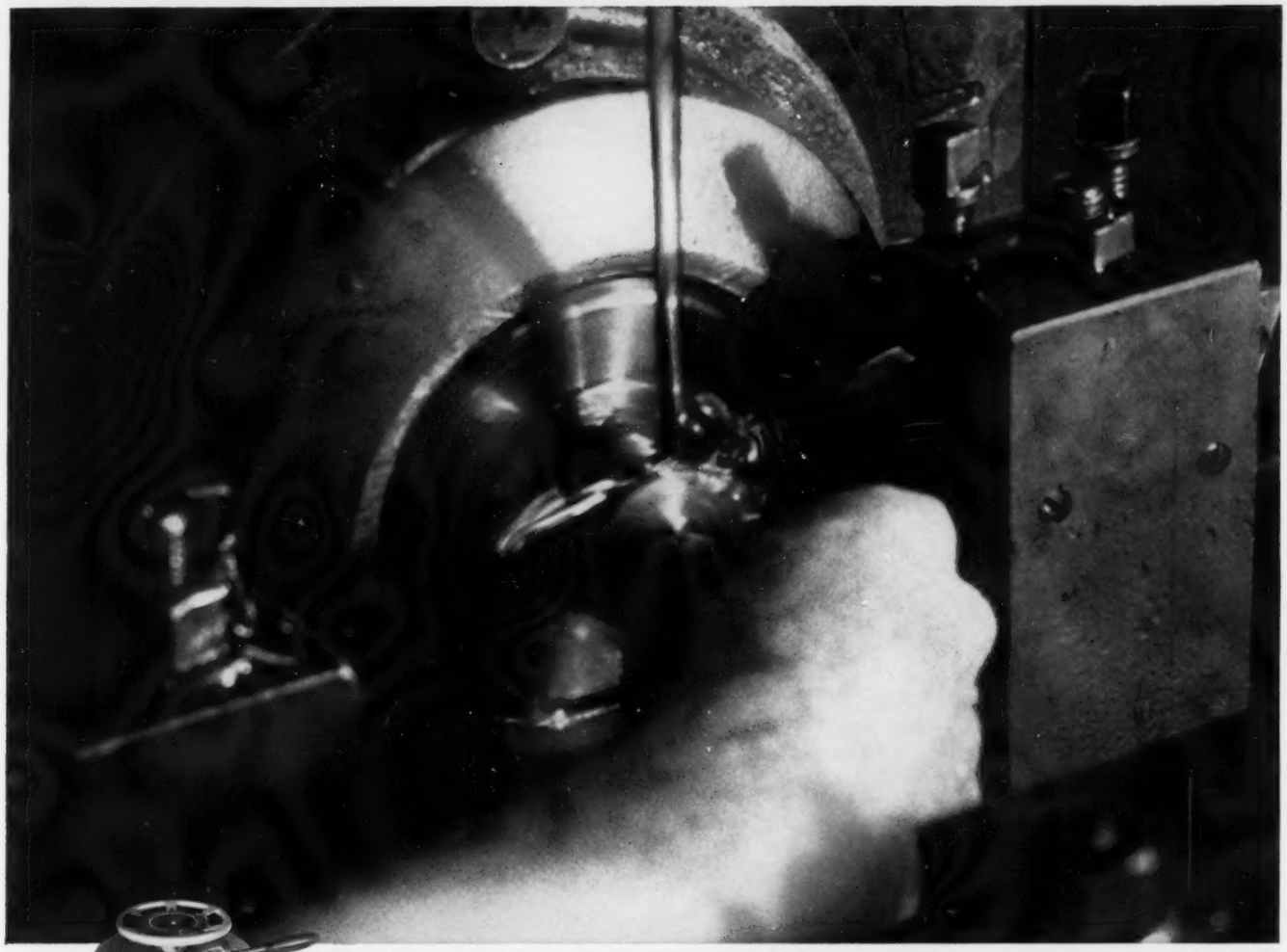
USE ASBESTOS WICK (Style No. 4202) to pack small valve stems on exhaust, vapor or low pressure lines . . . caulking retorts, ovens, boiler walls . . . as gasketing between cope and drag on foundry flasks . . . for emergency steam line repairs.

USE ASBESTOS ROPE (Style No. 4200) to wrap around hot lines . . . fill spaces in oven construction . . . blast furnace connection...for caulking larger apertures where dry heat is a factor.

These are only a few of the varied uses you will discover for Asbestos Wick and Asbestos Rope. They are supplied in a range of sizes up to two inches. Because of high purity, these J-M styles will handle much higher temperatures than commercial grade wick and rope. For further information, see your J-M Distributor. Or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ont. Offices throughout the world. Cable address: Johnmanvil.

JOHNS-MANVILLE

JM



COOL CUTS

Keeping close tolerances is of prime importance at Diagraph-Bradley Industries, Inc., of Herrin, Illinois, leading manufacturer of stencil machines and accessories. One of the ways this is accomplished is by keeping cutting edges cool.

At Diagraph-Bradley stencil punches must be cut and held within .0005 of an inch—a fine point of precision Diagraph-Bradley attributes to the cooling and lubricating effect of Cities Service Chillo 10 cutting oil.

"You have only to take a Diagraph-Bradley machine," says one of the company officials, "cut a stencil with it and look at the resulting letter to realize how important the right cutting oil is to our production."

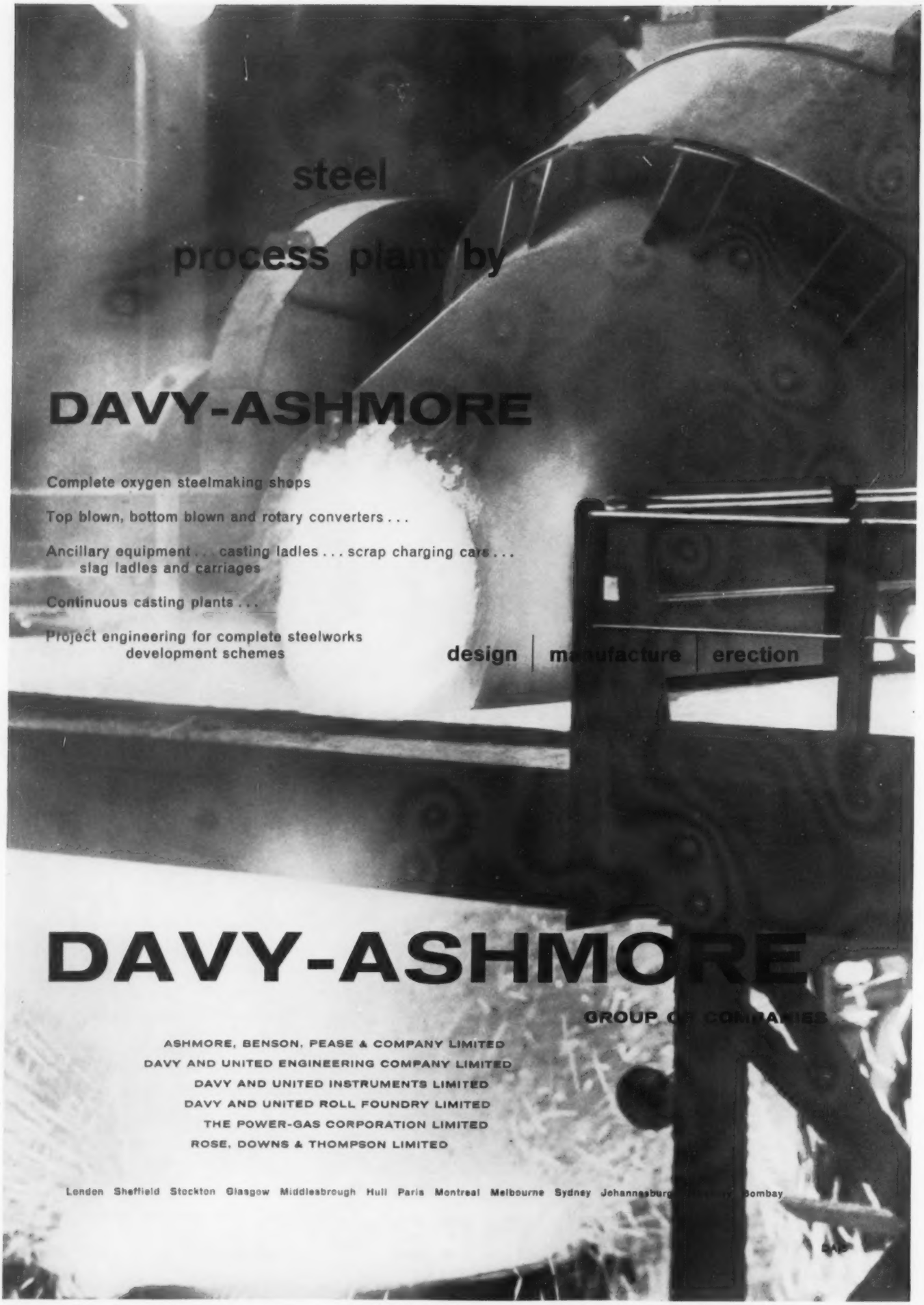
Cities Service Chillo 10 oil is a sulphochlorinated oil. The concentrations of sulphur and chlorine are stabilized by a special process, assuring uniformity of action through the entire cutting operation.

That's why, with Cities Service Chillo 10 cutting oil, work is always more accurate, clean and cool!

For full information call your nearest Cities Service office or write Cities Service Oil Company, Sixty Wall Tower, N.Y. 5, N.Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS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process plant by
DAVY-ASHMORE
Complete oxygen steelmaking shops
Top blown, bottom blown and rotary converters . . .
Ancillary equipment . . casting ladles . . . scrap charging cars . . .
slag ladles and carriages
Continuous casting plants . . .
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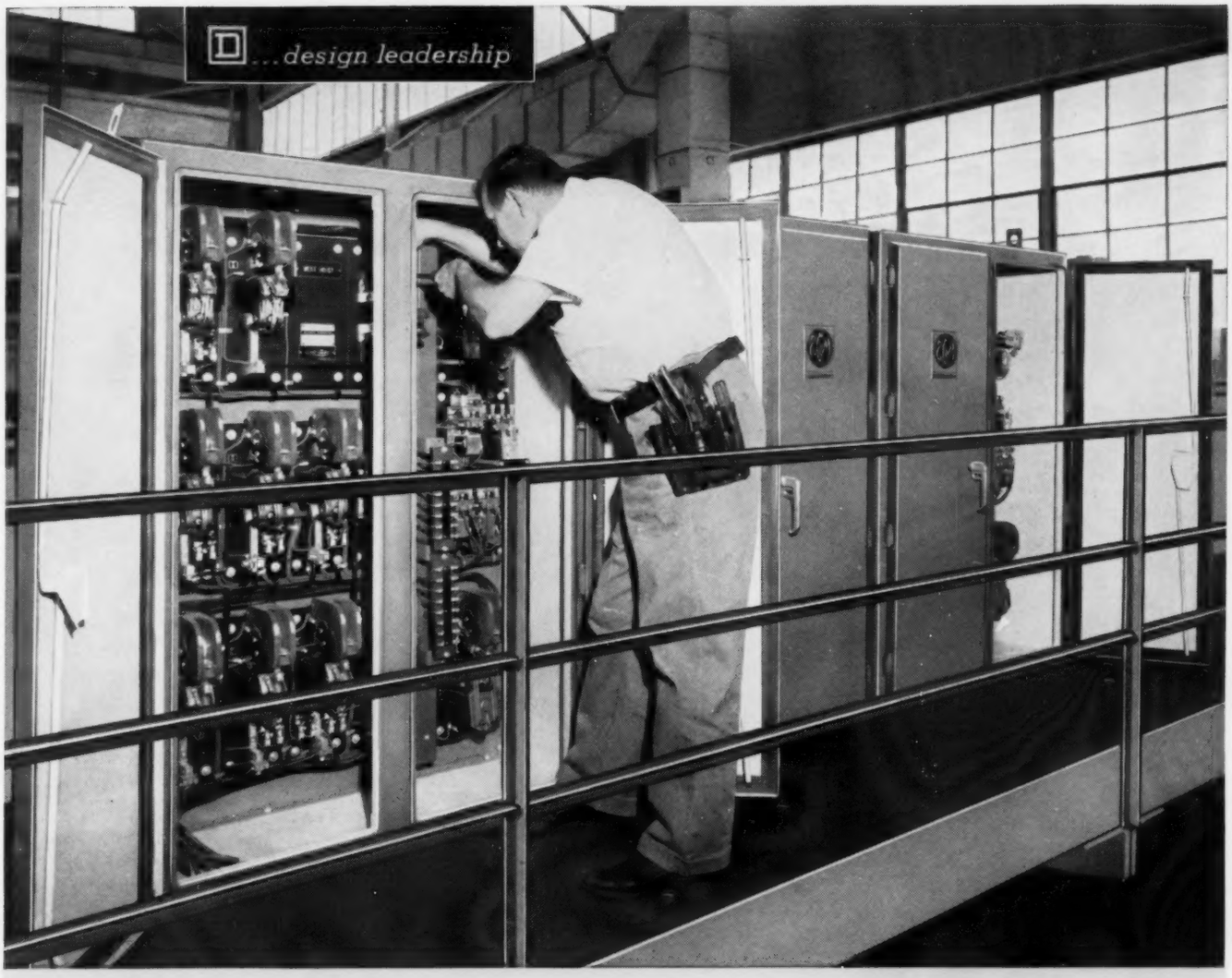


NEW! EC&M Front-Connected DC Control reduces catwalk width up to 20 inches

• When space is important, EC&M front-connected control can save you up to 20 inches of catwalk width. Moreover, the controllers are 10% to 15% lighter, can be backed up against girders. The result—a reduction in crane weight.

These new front-connected controllers provide the easiest maintenance of any available. All wiring and control components are accessible from the front, with ample working space inside the cabinet.

You get extra safety, too. Control components are mounted on insulated bases which in turn are mounted on panel studs projecting from the rear of the cabinet. The result is maximum insulation to ground.

EC&M front-connected control is available for single-motor DC drives up to 225 hp, with 2, 3 or 4 decks to suit headroom requirements. Includes exclusive Wright dynamic lowering circuit which gives maximum hook speed without danger of overspeeding.

Write for Bulletin 6121. Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio

SQUARE D COMPANY

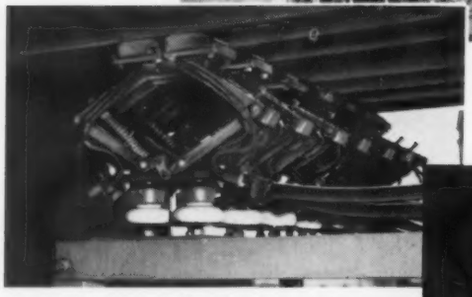
EC&M DIVISION • CLEVELAND 28, OHIO

wherever electricity is distributed and controlled

4160

U.S. Steel's new towering 629-foot ore bridge designed and built by American Bridge for National Tube Division's Lorain, Ohio, Works.

Shown below are the copper-head steel rails. These unusual conductors feature steel for strength and copper for current capacity.



Above are the specially designed pantographs, with carbon shoes, which maintain constant contact with the copper contact surface of the conductor rails under all operating conditions.

Chosen for its low maintenance and freedom from past conductor system difficulties; this Ringsdorff Current Conductor System is now an integral part of the great ore bridge at the Lorain Works of U.S. Steel. Ringsdorff Current Conductor Systems are easily adaptable to any normal or special application in American Industry.

The Ringsdorff Current Conductor System is now being manufactured in the United States.

For specific engineering assistance, contact:

RINGSDORFF CARBON CORPORATION

P.O. BOX 22 • EAST McKEESPORT, PA. • (PITTSBURGH DISTRICT)

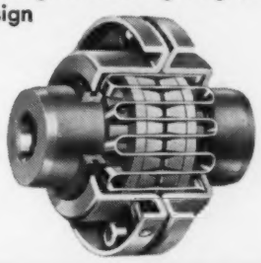
How one FALK coupling saved more than $1,000 per month

Pictured below is a Falk Steelflex Coupling assembly which connects a 2500 hp motor to a reduction unit driving an 18″ bar mill in a Midwestern steel plant. This coupling replaced another type which broke repeatedly, causing maintenance expense averaging $1,000 a month—plus costly production losses. Since installation of the Falk Coupling, with its controlled torque mechanism that disengages when a predetermined overload occurs, there has been no interruption of production. Savings in maintenance and in lost production time are well in excess of $1,000 per month...dramatic proof of the importance of coupling design!

Long coupling life is not the sole criterion of coupling performance. Inadequate shaft couplings may be the cause of bearing damage or shaft breakage on your machines. If so, a change to Falk Steelflex will give two-fold protection to your connected machines: (1) compensation for reasonable degrees of shaft misalignment, and (2) torsional resiliency to reduce peak loads as much as 30%. These advantages are as important to you as the long service life of the Falk Steelflex Coupling itself.

Falk Steelflex Couplings, in types and sizes to meet virtually all industrial applications, are promptly available from distributor, warehouse and factory stocks. Consult your Falk Representative or Authorized Falk Distributor.

Basic **Type F**—cutaway view showing exclusive grid-groove design



THE FALK STEELFLEX®
...a truly flexible coupling

Here is the coupling that has all the strength of steel, yet is truly flexible. *More than a million* have been bought for industrial service of many kinds.

Because, in addition to its inherent superiorities of design, the Type F Steelflex can be used horizontally or vertically without modification or special parts, it has been adopted as standard in many plants—and by many designers and manufacturers of industrial equipment...Write for Bulletin 4100.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in many principal cities

Good couplings not only connect machines; they prolong machine life and boost production!

New
B&W
REFRACTORIES FOR THE METALS INDUSTRY

B&W's line of refractories has been enlarged by the addition of new heavy duty firebrick and new ramming mixes. These new products, now offered after many years of developmental and field experience, are specifically designed for superior service in blast furnaces, electric furnace roofs, submarine ladles, metal mixers, soaking pits, billet and slab heating furnaces, salt bath furnaces, aluminum melting furnaces, lead melting furnaces, zinc recovery furnaces, nickel smelting and copper and brass furnaces.

FIREBRICK

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KAO-HB

HIGH BURNED SUPER DUTY FIREBRICK

Fusion point 3220 F. This brick offers an excellent balance of properties to assure superior service. It provides approximately 5% more alumina content and lower total impurities than competitive brick. It has excellent spalling resistance.

KAO 60

60% ALUMINA FIREBRICK

Fusion point 3250 F. Provides higher hot load strength than any competitive brick. Spalling loss is only 1%.

KAO 70

70% ALUMINA FIREBRICK

Very low total impurities provide long life. Spall loss of only 2%.

RAMMING MIXES

★

MULRAM E

USE LIMIT 3200F
ALUMINA CONTENT–80%

This new ramming mix with extremely low permeability provides exceptional resistance to slag or molten metal penetration. High strength provides good erosion resistance.

MULRAM EF

USE LIMIT 3100F
ALUMINA CONTENT–80%

Similar to Mulram E but supplied in finer grain.

FOR COMPLETE PROPERTIES SHEETS and additional information on these new B&W Refractories products, write to The Babcock & Wilcox Company, Refractories Division, 161 East 42nd Street, New York 17, N. Y.

R-457

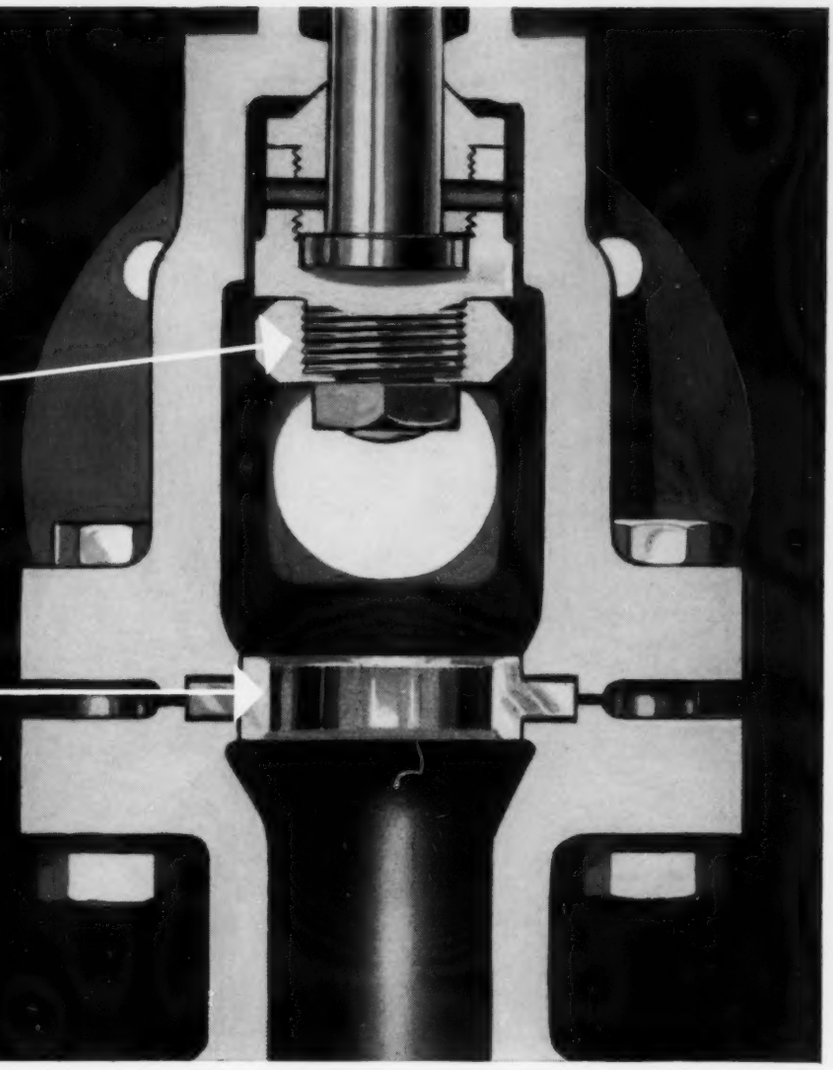
B&W

THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

EXTRA SEAT *and* DISC FREE



in every Homestead® Boiler Blow-Off Valve!

Simply reverse Monel seat and disc (which are ground and mated) and you have a valve as good as new. Resistant to corrosion and erosion, these Hovalco Angle Valves are built to outlast your boiler. They take all the abose of throttling or controlling rate of blow-off, yet give long, outstanding service. They're built for quick inspection, rapid repair. Used in tandem with any of three types of Homestead Quarter-Turn Plug Valves, Hovalco Angle Valves meet all requirements of State and Province Boiler Laws and A.S.M.E. Code. Mail coupon for full information.

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HOMESTEAD VALVE MANUFACTURING COMPANY
"Serving Since 1892"
P. O. Box 160—Coraopolis, Pennsylvania

Please send me Reference Book 39-4 on Homestead Boiler Blow-Off Valves.

Name.....Position.....

Company.....

Address.....

City.....Zone.....State.....

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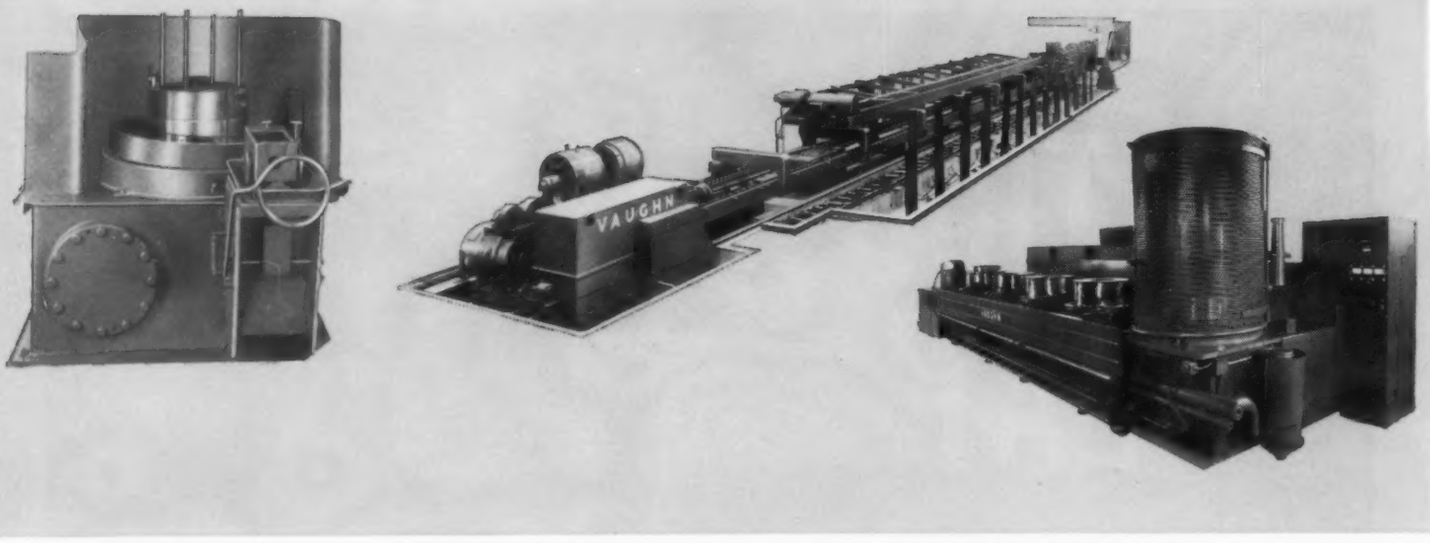
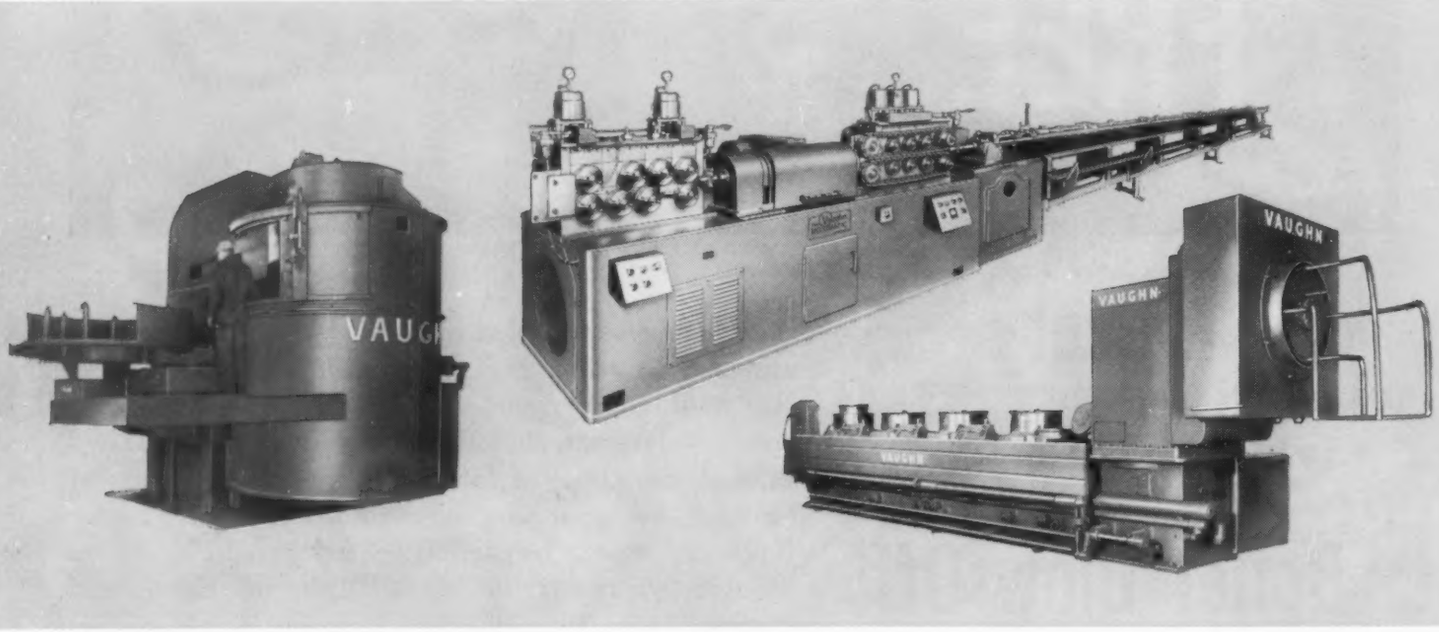
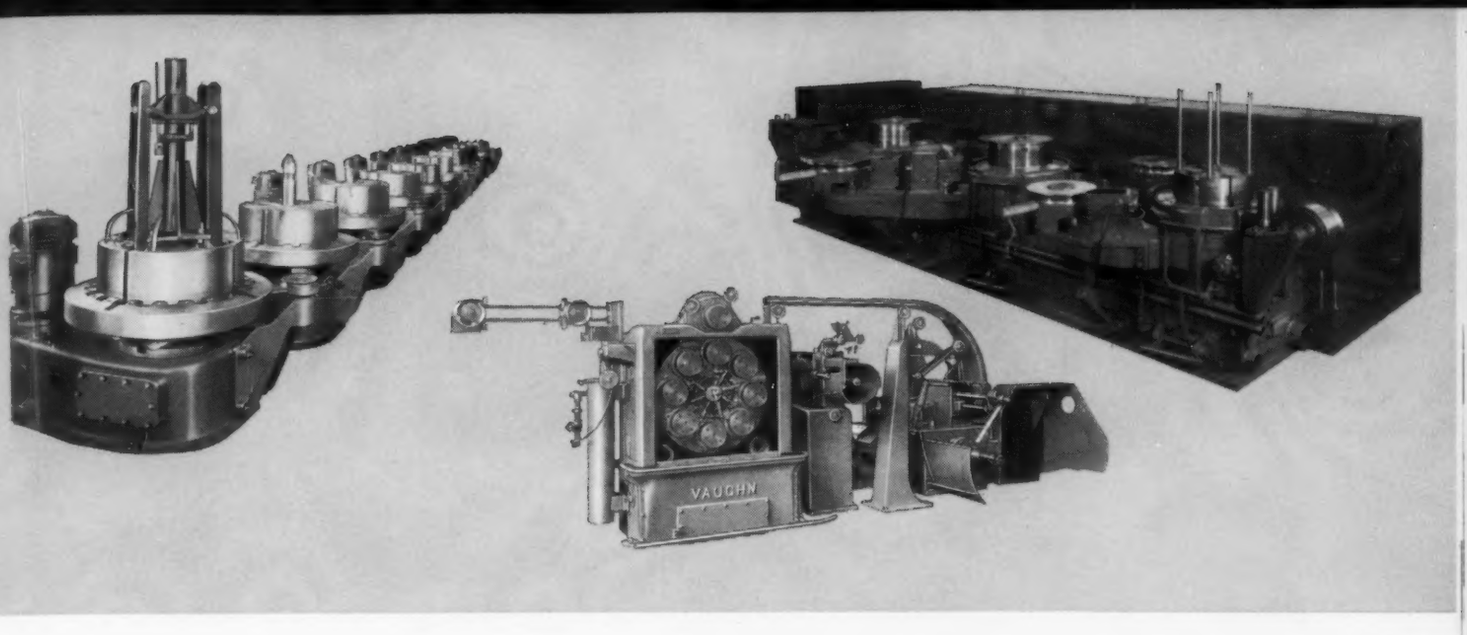


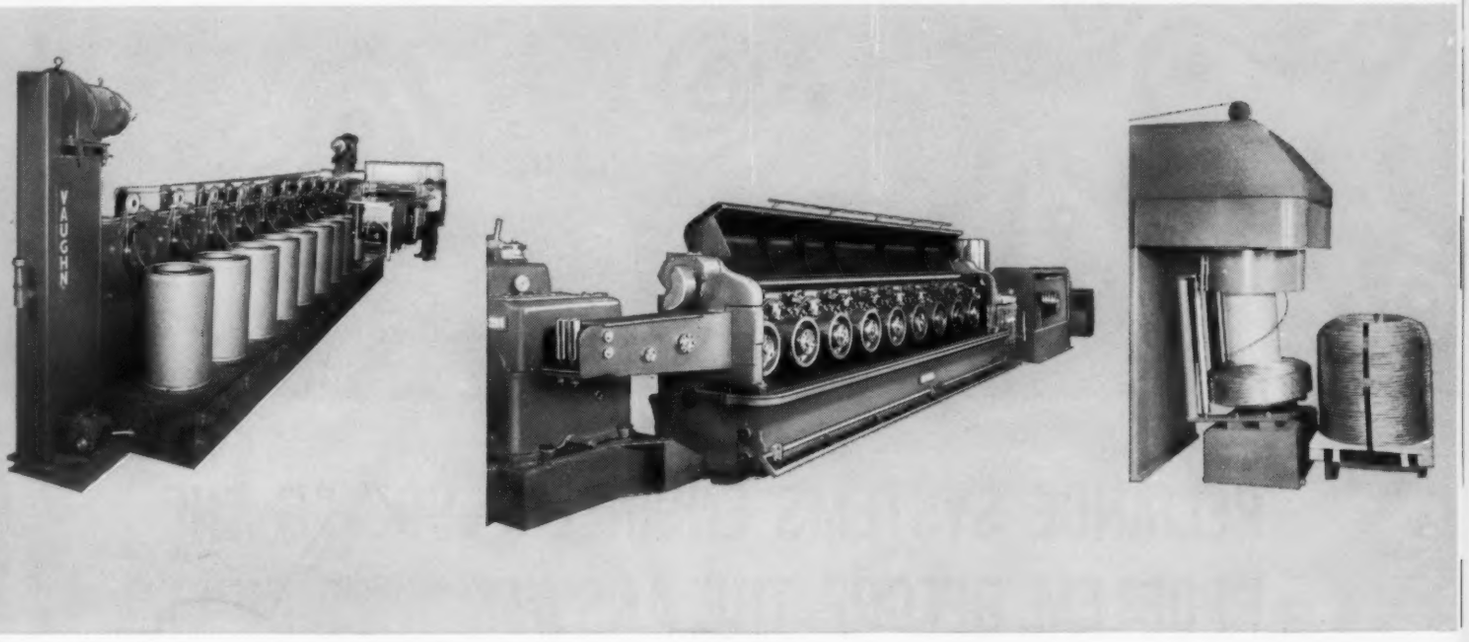
IF IT'S COLD DRAWN



The World's Most COMPLETE LINE of Cold Drawing Equipment ... for the Largest Bars and Tubes ... for the Smallest Wire ... Ferrous, Non-Ferrous Materials or their Alloys.



...SEE VAUGHN!

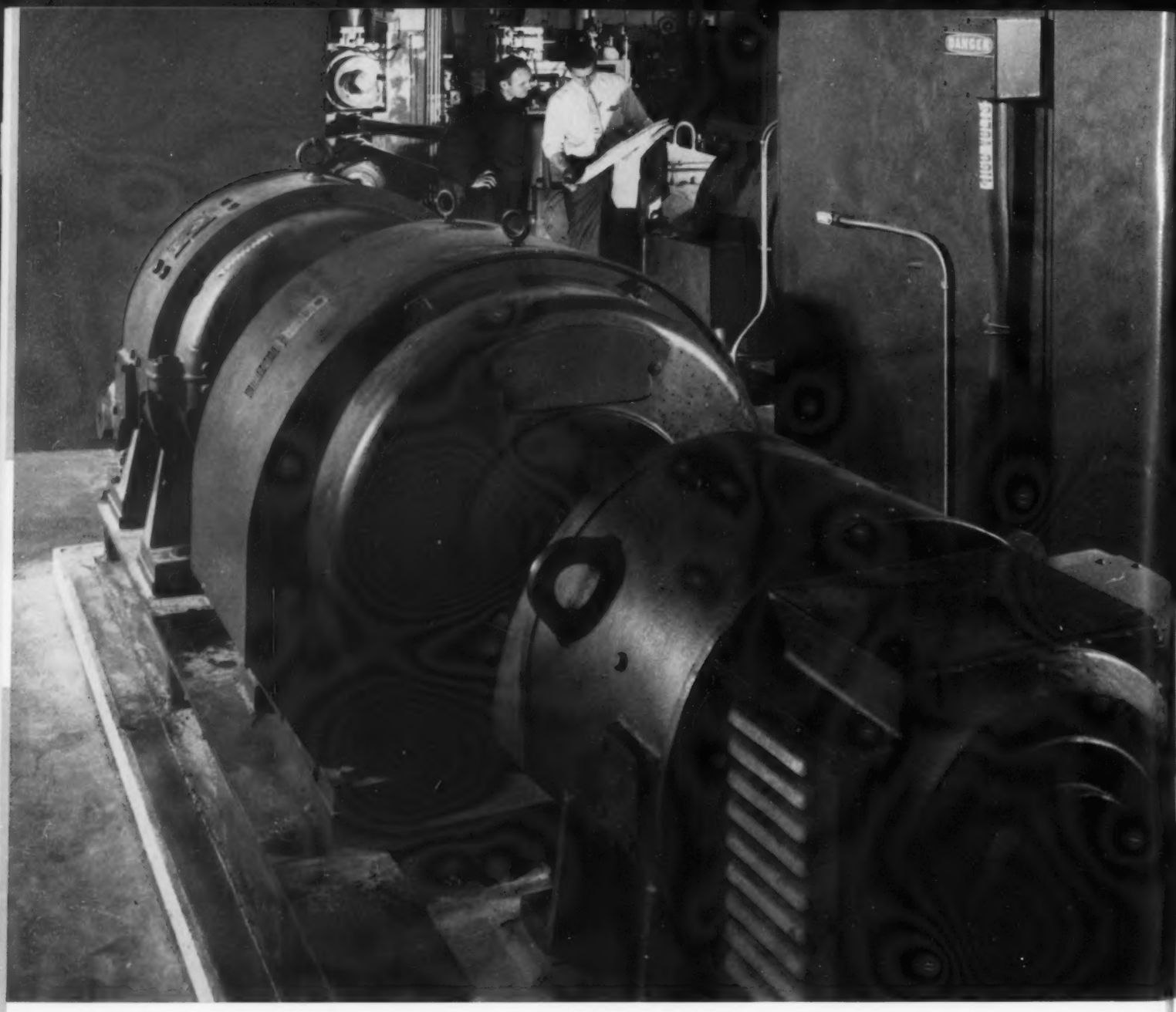


"Quick on the Draw!"

When cold drawing is part of your production picture, come to the leading equipment manufacturer for every service you may require . . . consultation, design, layout, quotations . . . and the broadest choice of cold drawing and related machinery in the world. You'll find Vaughn co-operation as complete as our resources. Let us serve you!

THE VAUGHN MACHINERY COMPANY

CUYAHOGA FALLS, OHIO, U.S.A.



RELIANCE SYSTEMS ENGINEERS SOLVED THE PROBLEM BEFORE THE ANSWER WAS BUILT

It works precisely, as they said it would.

What you see is the source of D-c. power for a dual-purpose cold mill . . . Reliance motors, generators and mill controls. What you don't see, but what the customer gets, is extreme accuracy and smooth, economical operation, from Reliance Systems Engineering.

The cold mill itself uses four rolls for cold reducing . . . two rolls for tempering and finishing. A 250 hp. Reliance D-c. motor powers the mill and can be quickly coupled to either set of rolls, depending on the operation selected. Utilization of full motor speed range produces a maximum of 300 feet per minute on 8″ or 20″ rolls. The reel is driven by a 100 hp. D-c. motor with two VSR regulators, one to match the speed of the mill—the other to maintain tension. Reliance Engineers determined the *right* regulators to use and *how* to use them, saving this customer equipment and operating costs.

Reliance Systems Engineers can apply their talents to your systems operations—in advance—give you the thinking and the products that do the job you want and need. Can we help you?

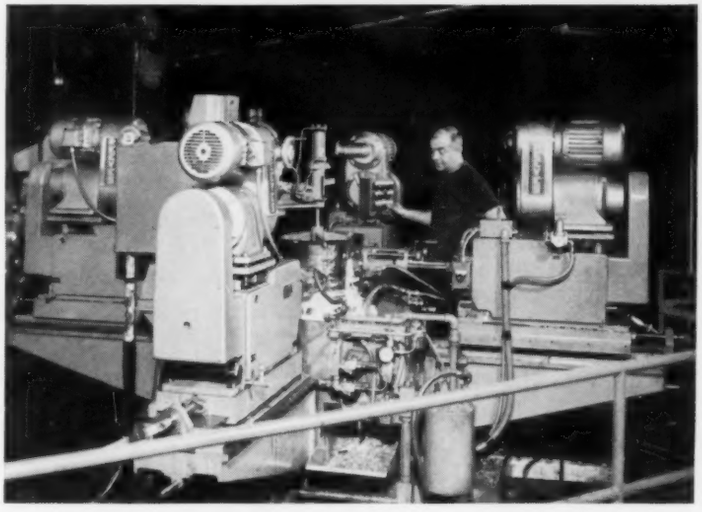
BUILDERS OF THE TOOLS OF AUTOMATION

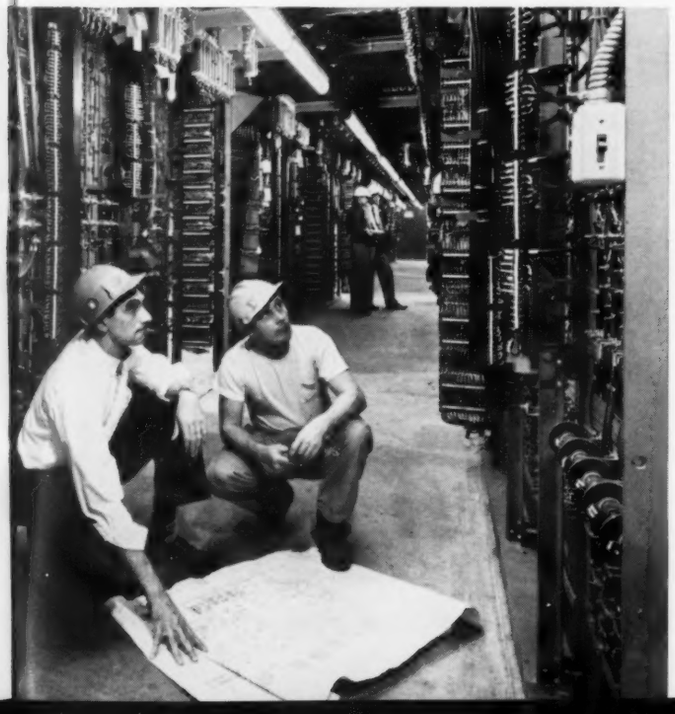
A-1682

ONE SELF-CONTAINED, COMPACT POWER PACKAGE. This MASTER GEARMOTOR has been operating outdoors for 5 years regardless of weather. It has no exposed high speed couplings, no V-belts, chains or sprockets. Engineering and assembly costs are reduced. You can simplify installations and save space with vertical, horizontal and flange mountings; output shaft over, under, left or right. Ratings 1/8 to 125 hp. in right angle, parallel or in combination. Right angle ratios are available in 96:1; parallel 120:1. Bulletin E-2409.

CONTOUR EPOXY-COATED TO ELIMINATE ENCAPSULATION CRACKING. New RELIANCE ENCAPSULATED MOTOR . . . gives you positive protection from dust, dirt, acid and water. Unlike other heavy molded coatings, stator windings are vacuum-impregnated with epoxy resin at a uniform thickness, follow the contour of the windings. You get maximum flexibility, tensile and bond strength, plus quicker cooling . . . all vital to superior motor performance. Bulletin B-2108.

INFINITELY VARIABLE OUTPUT SPEEDS AT LOW COST. REEVES MOTODRIVES, shown here powering this 4-position drilling and boring machine, are used extensively for hundreds of production needs. Horsepower ratings from ¼ to 40, speeds from 1.71 to 4660 rpm. Speed variation ranges from 2:1 to 10:1. Available in hundreds of space-saving assemblies . . . with manual, remote or automatic process control (Airtrol). Bulletin M-592.





TOTAL SERVICE is an integral part of every Reliance product, from engineering and start-up assistance to maintenance and renewal parts. The photo shown here is typical of a Reliance Service Engineer's on-the-job availability—for maintenance and consultation on knotty problems. Every Reliance Sales Engineering Office and Distribution Center—nationwide—gives you the attention and experience necessary to assure the top performance you expect from the Reliance equipment you buy.

RELIANCE ELECTRIC AND ENGINEERING CO.

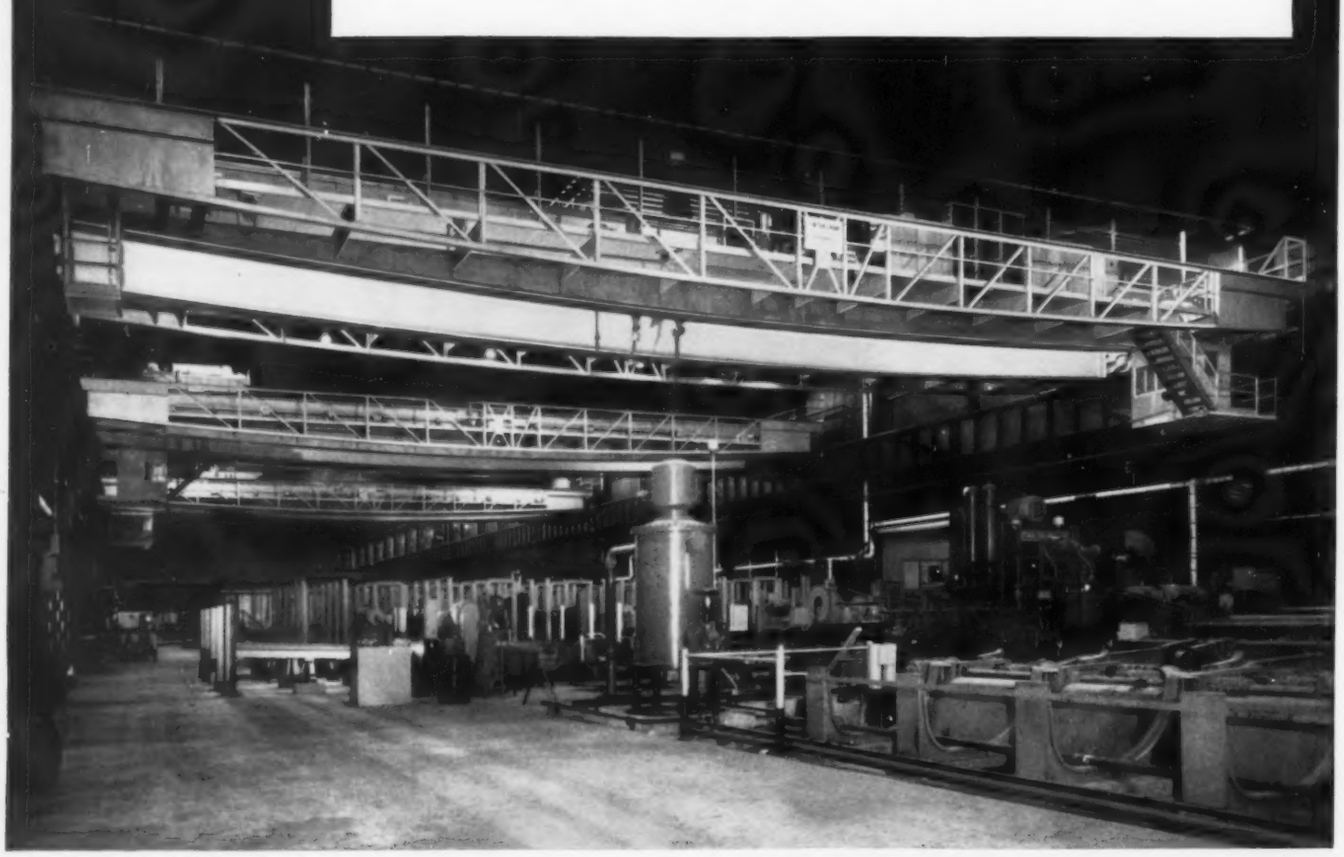
DEPT. 112A, CLEVELAND 17, OHIO • Canadian Division: Toronto, Ont.

AMERICA'S LARGEST STEEL MILLS USE BROWNING CRANES

Built to A. I. S. E.
Specifications or Your Own

For years, Victor R. Browning & Co. has devoted major time and study to the building of heavy duty mill cranes. The finest materials and workmanship go into the construction of these cranes. All shafts are of the highest quality alloy steel. All bearings are calculated with a proper life factor as required by the A. I. S. E. We will design to suit your special requirements or build to your specifications . . . Victor R. Browning & Co. also makes a complete line of trolleys which can be adapted to existing bridges.

VICTOR R. BROWNING & COMPANY, INC.
WILLOUGHBY (CLEVELAND), OHIO



For

OXYGEN STEELMAKING PROCESSES

consult

WELLMAN

Marking a new departure in the practical field of oxygen steelmaking, this 20 ton unit for refining blast furnace metal was designed, in collaboration with the Brymbo Steel Works, and constructed by Wellman.

Refining is effected by injecting oxygen and powdered lime, through automatically controlled lances, into the bath.

The vessel has provision for:— slagging, adding scrap and fluxes, fettling, and sampling during operation.

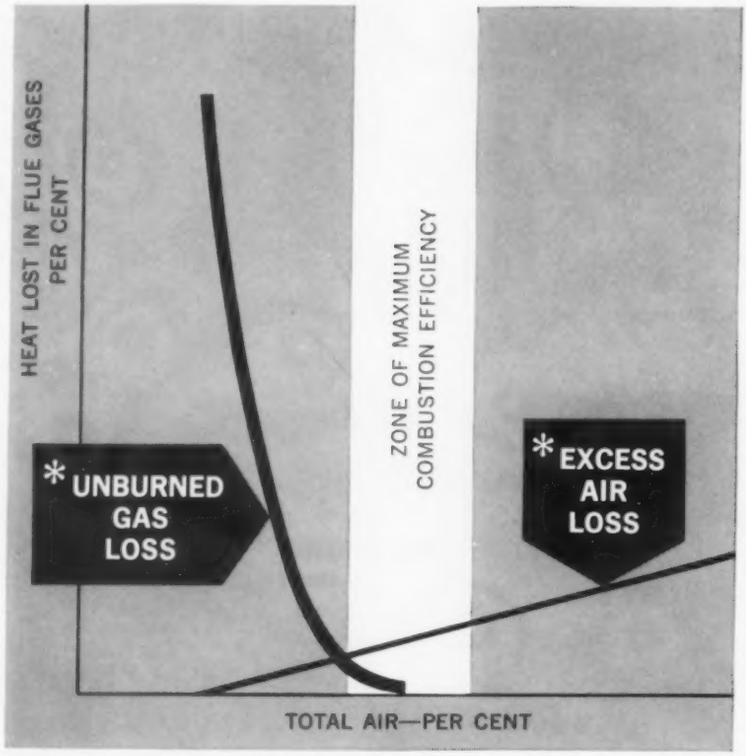
This is a further example of Wellman activities in providing designs and equipment for new steelmaking techniques involving the use of tonnage oxygen.

BRITAIN'S *foremost builders of steelmaking plant*

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LTD.

PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1 WORKS: DARLASTON, South Staffs, & BELFAST.

You must know BOTH* to get maximum combustion efficiency!

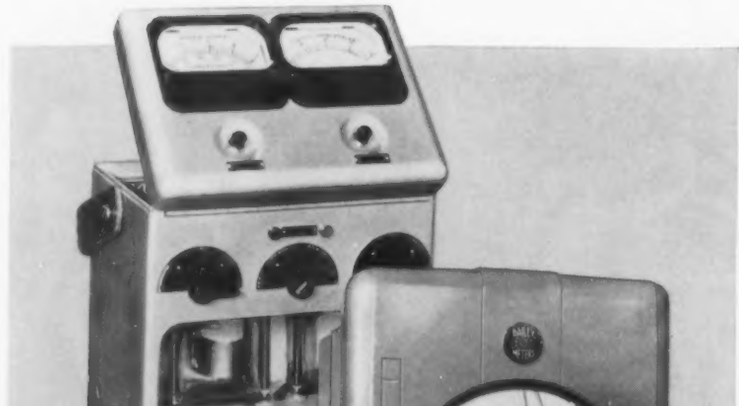

HEAT LOST IN FLUE GASES PER CENT
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
* UNBURNED GAS LOSS
* EXCESS AIR LOSS
TOTAL AIR—PER CENT

How much money is going up the flue in *unburned fuel* losses? Is too much air resulting in excessive *heat* losses?

You must know *both* facts—simultaneously—to get optimum combustion. No instrument that measures only one of these interdependent factors can give you the full information you need.

Bailey offers a choice of two direct ways to maintain a continuous and simultaneous double check on these factors that determine combustion efficiency. The portable, lightweight Bailey HEAT PROVER Analyzer indicates both; the Bailey Oxygen-Combustibles Analyzer-Recorder records both on a single chart. Both instruments measure excess air, regardless of fuel or fuels being burned, and per cent of combustibles in flue gas.

Either of these Bailey instruments can save you far more than their cost in spotlighting combustion inefficiencies. Ask your Bailey engineer or write for product specifications.



2 DIRECT WAYS to measure both combustibles and oxygen simultaneously

PORTABLE INDICATOR—Self-contained, lightweight, Bailey HEAT PROVER Analyzer enables quick, easy check on combustion conditions. Dual range dials for greater accuracy and readability.

PERMANENT RECORDER—Bailey Oxygen-Combustibles Analyzer-Recorder coordinates both records on one chart . . . is designed for permanent installation . . . helps maintain optimum ratio continuously.

* Unburned gas loss and excess air loss.

G 155-1

Instruments and controls for power and process

BAILEY METER COMPANY

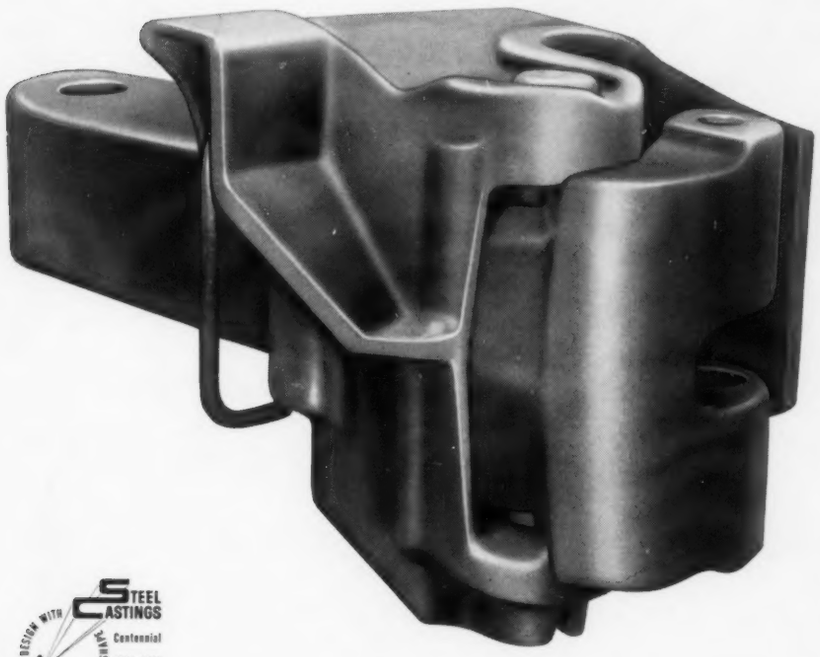
1047 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

THE IDEAL COUPLER
FOR INDUSTRIAL HAULAGE

SHARON-10A

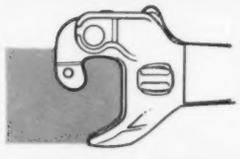


National's Sharon-10A Automatic Couplers are in use throughout the world on industrial cars, mine cars, railroad cars and transit cars. They can be furnished for varying service requirements such as regular top and bottom operation, improved type G side pull, type F side pull, rotary side or rotary bottom operation. For smaller cars not warranting use of the full-size Sharon-10A coupler, they can be furnished in 3/4 size as the Sharon-10 instead of with the full 10A contour.

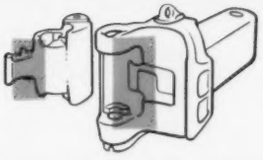
STEEL CASTINGS Centennial 1861-1961 DESIGN WITH STRENGTH IN SHAPE

A-1285A

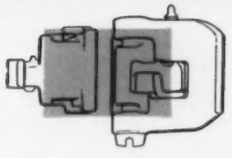
SHARON-10A • SHARON-10A • SHARON-10A



Gives longer service life. Liberal allowance for wear and distortion.



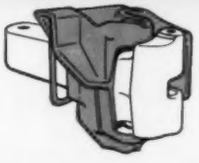
Has greater buffing strength. Substantial buffing shoulders in coupler head and knuckle.



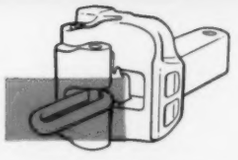
Has less pulling stress. Lugs reduce stresses on knuckle pin.

SHARON-10A • SHARON-10A • SHARON-10A

Features secure locking. V-shaped design stabilizes lock in coupler wall.



Is protected from molten metal. Hood protects uncoupling mechanism from metal splash.



Is versatile. Can be supplied with slotted or off-set knuckle for use with present link and pin equipment.

GEARED TO PROGRESS P R I MEMBER

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

Established 1868

Transportation Products Division
Cleveland 6, Ohio

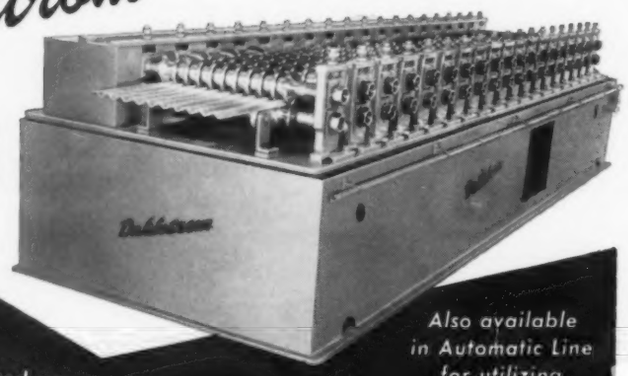
International Division Headquarters
Cleveland 6, Ohio

CANADIAN SUBSIDIARY
National Malleable and Steel Castings Company of Canada, Ltd.
Toronto 2-B, Ontario

COUPLERS • YOKES • DRAFT GEARS • FREIGHT TRUCKS • JOURNAL BOXES
NATIONAL SPEEDLOADER CONTAINER HANDLING SYSTEM

CORRUGATE SHEETS with a

Dahlstrom ROLL FORMING MACHINE



FEATURING:

- All welded construction.
- Roll shafts mounted on anti-friction bearings.

Also available in Automatic Line for utilizing coil stock.

Major Building Products Manufacturers use this setup for corrugating 20 through 28 gauge galvanized steel, plain and embossed aluminum.

Requires only vertical adjustment for gauge range. Roller die tooling available for various depths. Excellent control of coverage and depth. No length restrictions.

Other gauge ranges also available. Send complete detailed specifications for quotation.

Dahlstrom MACHINE WORKS INCORPORATED

4226 W. Belmont Ave., Chicago 41, Ill. Phone: SPring 7-3670

•

DAHLSTROM also manufactures a complete line of equipment for fabricating Coil and Sheet Metal.

•

- **ROLL FORMING MACHINES**
- **SLIDING DIE-TYPE CUT-OFF PRESSES**
- **COIL REELS**
- **COIL LIFTS**
- **ROLL STRAIGHTENERS**
- **PRESS FEED EQUIPMENT**
- **DECOILING AND SHEARING LINES**

•

HOW TO CUT HIGH MAINTENANCE COSTS . . . SPEED CUTTING OPERATIONS

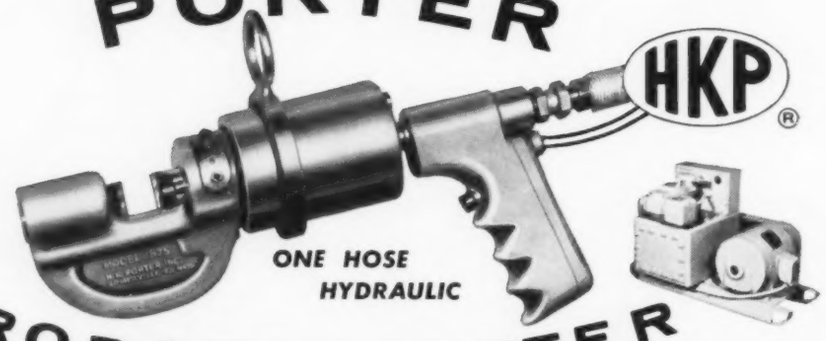
From rod and wire mills everywhere come reports that down-time for repairs is practically non-existent with the Porter Hydraulic. Add to this — *faster* cutting, and you have these vital ingredients for boosting your production. Two features found *only* in Porter Cutters make this efficiency possible.

CUTTER BLADES WITH MORE BEARING SURFACES .... WON'T BREAK DOWN!

Because blades are longer they have more bearing surfaces for *rigid* alignment, thus eliminating any side thrust which causes breakage.

Filtered air taken into the cylinder is forced out around the movable blade on each cut, eliminates danger of dirt reaching bearing surfaces causing oil leakage and wear.

PORTER HKP®



ROD & BAR CUTTER

A HYDRAULIC SYSTEM OF FOOL-PROOF DESIGN! One-hose design cuts replacement costs in half. Adjustable relief valve saves wear and tear by providing the correct pressure for any cutting job. Hydraulic oil is filtered by an easy-to-change 40 micron oil filter. And a safe 12-volt control switch on the cutterhead gives instant finger-tip control of the cutting action.

WRITE FOR ON-THE-JOB DEMONSTRATION OR ROD AND BAR CUTTER CATALOG

AVAILABLE NOW! 3 CUTTERHEADS with capacities up to 1⅜" steel rods. 5 HYDRAULIC POWER UNITS. Matched to your exact requirements. Specially designed heads for other non-cutting applications, such as punching, crimping, heading, forming.

H. K. PORTER, INC.,
Somerville 43, Mass.

CLEVELAND TRAMRAIL
AUTOMATIC HANDLING SYSTEMS

Long Hauls • Heavy Loads
Big Man-Hour Savings

ROBOT materials handling systems are here. Cleveland Tramrail has a wide variety of them in use in many plants. Some operate inside, some outside; some between machines, departments, or building floors; some between distant plants (as illustrated above). Some carriers travel between two points; others serve as many as 126 stations.

Operators are not needed for robot carriers. Pressing a button sends a carrier on its way. At the delivery point it stops automatically. After unloading and reloading, pressing another button returns it to the original station or to some other station as selected.

Cleveland Tramrail automatic carrier systems are available for loads of 1000 lbs. to 10 tons. They will lift loads to heights of 100 feet, if necessary, and carry them for practically any distance. Some carriers even unload and return automatically.

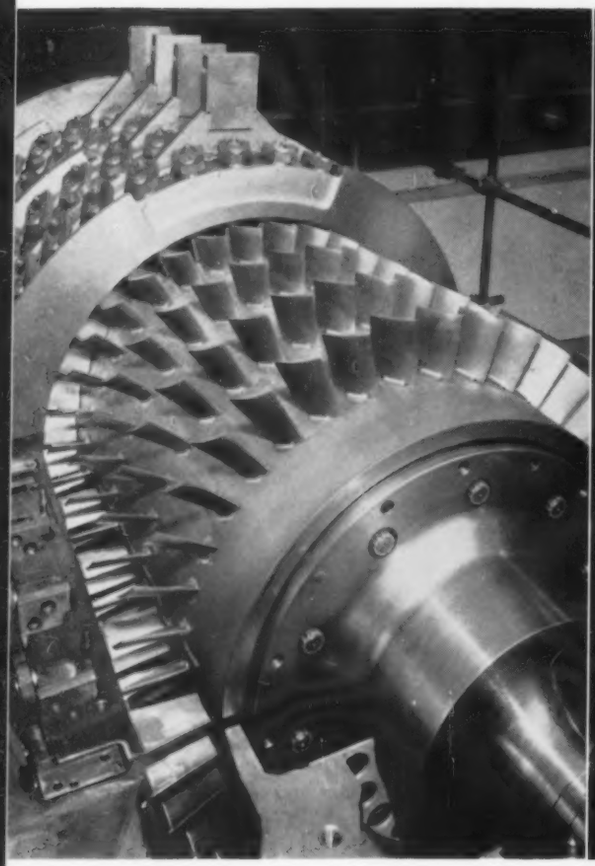
The man-hour-saving possibilities that Cleveland Tramrail Automatic Handling Systems offer you are tremendous—and there are other important advantages. It will pay you to get acquainted with this rapidly spreading idea of materials handling.

GET THIS SPECIAL REPORT
Write us for your free copy of "AUTOMATIC DISPATCH PORTFOLIO" Gives data on a variety of cost-reducing automatic handling installations.

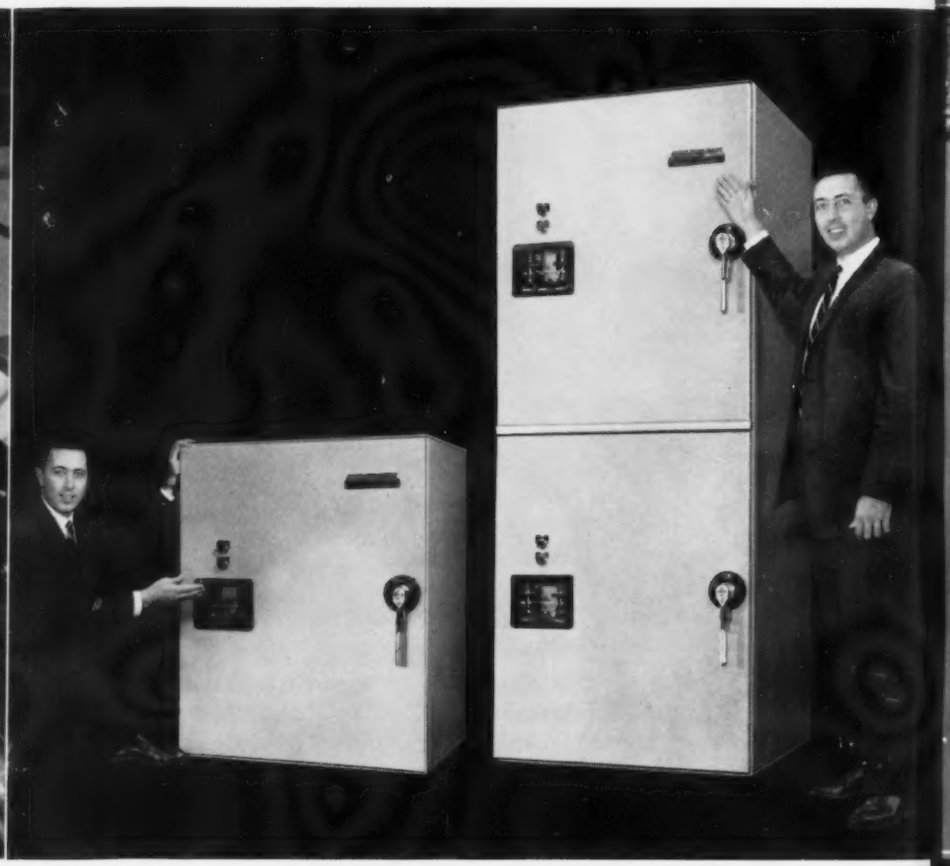
CLEVELAND TRAMRAIL DIVISION
THE CLEVELAND CRANE & ENGINEERING CO.
5010 EAST 290th STREET, WICKLIFFE, OHIO

CLEVELAND TRAMRAIL
OVERHEAD MATERIALS HANDLING EQUIPMENT

A-C ideas and news:



Fully adjustable stator blade control: Extends range of highly efficient axial compressors. Combines ability to meet fluctuating demands at constant speed with basic axial design advantages . . . steam savings of over 10%, and space and weight savings 25 to 50% of that required by comparable centrifugal compressors.



So low, two fit where one used to go: This new SpaceMaker control center is the first completely new 2- to 5-kv motor controller in more than a decade. Two-high design can cut floor space requirements in half. Complete drawout construction makes it the safest, most easily accessible controller on the market. New flame-retardent, track-resistant Super Pyro-Shield insulation adds to reliability, reduces size and weight. And, the all-new roll-out contactor is designed to cut maintenance time.

Which of these productive ideas could be working for you?

Screens that can't blind. Compressors with adjustable capacity at constant speed. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industrial Equipment Division, 900 S. 70th Street, Milwaukee 1, Wisconsin.

A-1399

Systemation is an Allis-Chalmers servicemark. *SpaceMaker* and *Pyro-Shield* are Allis-Chalmers trademarks.

For quality control . . . lower processing costs: Systemation engineers at Allis-Chalmers will undertake responsibility for the design of complete operating facilities. Systemation service is based on a thorough understanding of your processing requirements gained from years as a major equipment supplier to your industry. Added is the experience of over 500 successful advanced electronic control systems by Consolidated Systems Corporation, an affiliate company.

Sixty-eight motors power plating rolls: When this electrolytic tin line went into operation in 1960, 68 Allis-Chalmers totally-enclosed fan-cooled dc gearmotors powered the plating rolls. Additional Allis-Chalmers motors and supporting motor-generator sets provide power throughout the line. Whether small process line drives such as these, or huge main mill drives, A-C motors have earned a reputation for long life and trouble-free operation.

Screen moist, sticky ores without blinding: Allis-Chalmers new loose-rod deck for vibrating screens makes finer separations — down to ⅜ or ¼ in. — at increased capacity and improved efficiency. The rods roll and bounce, freeing themselves of sticky material. Similar cost-saving advantages are also found in A-C hot sinter screens and sizing screens.

A-C INDUSTRIAL EQUIPMENT DIVISION: motors, generators, controls, rectifiers, pumps, compressors, grinding mills, screens, industrial systems.

OTHER A-C PRODUCTS: thermal, hydro and atomic electrical generating equipment; switchgear, transformers, unit substations; tractors, earth-moving equipment, engines, lift trucks.

ALLIS-CHALMERS

SCHLOEMANN

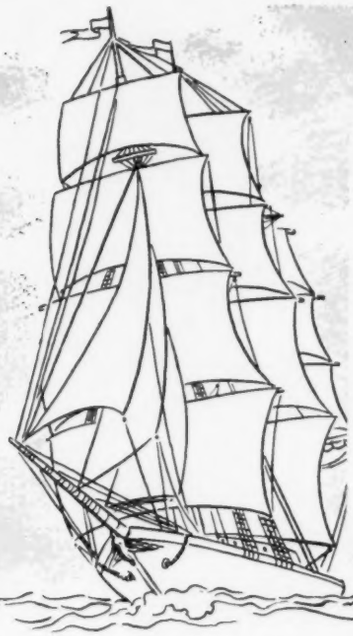
Multi-purpose plate bending press

Great rigidity to eccentric loading and resilience at the gap within close limits are the essential features of this SCHLOEMANN press. Its direct driven rams, powered by self-contained oil pump units, are controllable according to travel or pressure, making the machine suitable for multi-purpose application. It can be employed with equal efficiency for bending, drawing, flanging, joggling and straightening work, as well as for cutting, stamping and folding duties. The pump delivery for the rams is infinitely variable from the control desk. The force exerted, which is 2 x 250 tons in the vertical and 160 tons in the horizontal – adjusts itself exactly to the forming resistance. The oil pumps permit power application of any length of time at maximum pressure.

FELLER ENGINEERING COMPANY 1161 Empire Building, Pittsburgh 22, Pa.

Why Rust-Oleum is different—

and what this difference, backed by 35 years of industry proof, means to you!



A Sea Captain developed it . . . Industry proved it!

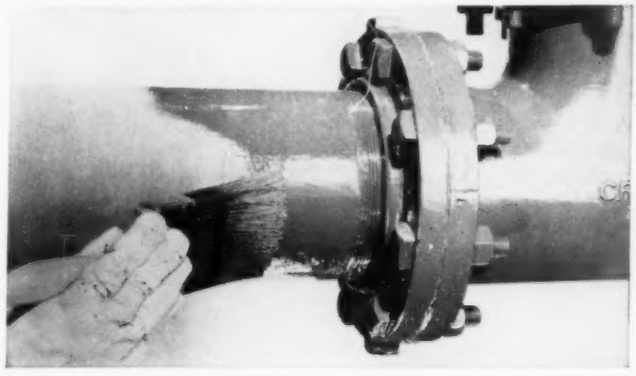
The original Rust-Oleum formula was developed nearly fifty years ago by Sea Captain Robert Fergusson, who became intrigued with the rust-stopping qualities of fish oil early in his career. Creating a *special treatment* for the fish oil, he used the *specially-processed fish oil* as the vehicle in combination with fine rust-inhibiting pigments. The result? A coating that actually *stopped rust* when applied directly over sound rusted surfaces, after scraping and wirebrushing to remove rust scale and loose rust. Possible, because the *specially-processed* fish oil penetrated the rust to bare metal. This was the birth of Rust-Oleum's *exclusive* 769 Damp-Proof Red Primer.

PROVED THROUGHOUT INDUSTRY FOR OVER 35 YEARS

Today, Rust-Oleum in its many systems and colors, has been proved throughout industry for over thirty-five years. This proof by leading industrial users is your assurance of savings in time, money, and metal. Economies made possible by the fact that Rust-Oleum 769 Damp-Proof Red Primer goes right over the sound rusted metal—usually eliminating costly surface preparations. And Rust-Oleum, in its various systems, resists rain, sun, fumes, heat, weathering, chemicals, etc., for lasting beauty over the years.

RUST-OLEUM NEW COLOR HORIZONS SYSTEM

The Rust-Oleum New Color Horizons System introduces a new coating concept to industry. It combines four important factors: (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, pipes, tanks, structural steel, fences, etc. Write for complete information or contact your nearby Rust-Oleum Industrial Distributor. He maintains complete stocks for prompt service.



RUST-OLEUM®

There are imitations, but only *one* Rust-Oleum. It is distinctive as your own fingerprint.

STOPS RUST!®

ATTACH TO YOUR LETTERHEAD

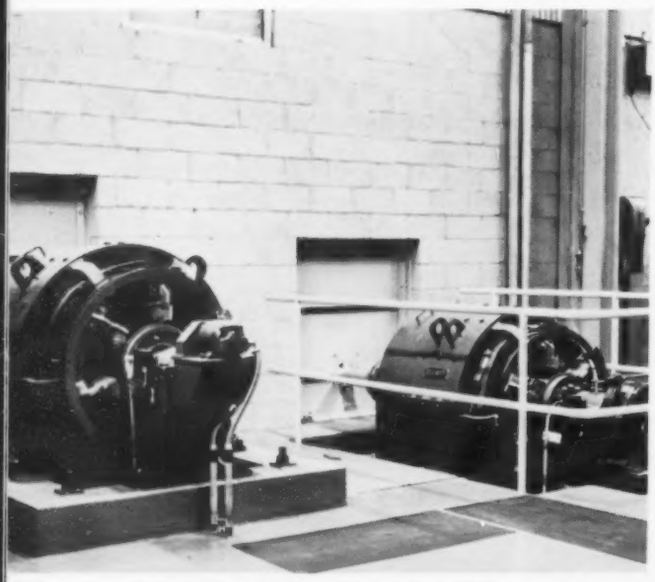
Rust-Oleum Corporation
2600 Oakton St, Evanston, Illinois

Please send me the following at no cost or obligation:

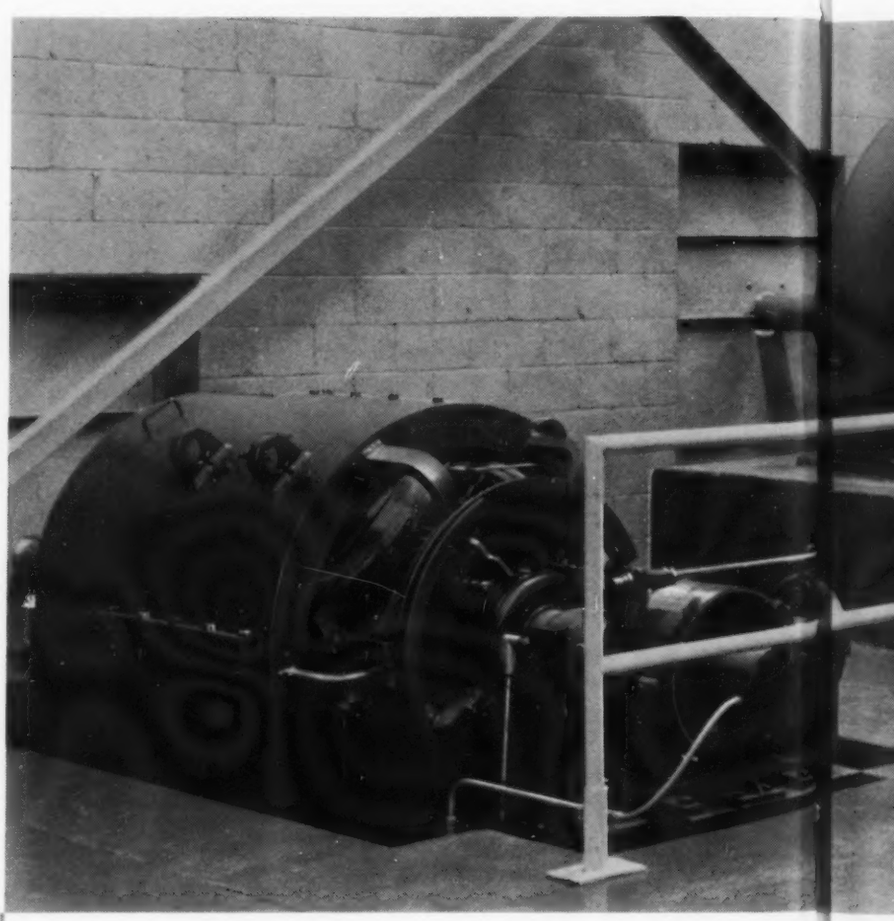
- ☐ New Color Horizons Systems Catalog featuring 110 actual color standards and 69 photo applications.
- ☐ Free test sample of Rust-Oleum 769 Damp-Proof Red Primer to be applied over sound rusted surface.
- ☐ Results of radioactive tracing study on Rust-Oleum fish oil penetration.

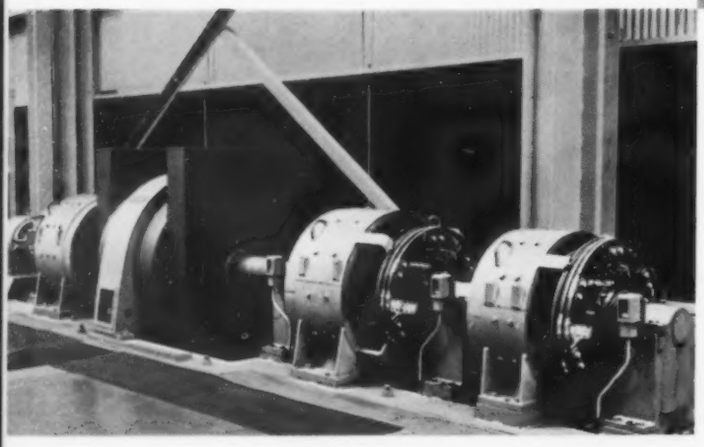
Right—One of the Elliott control panels in the motor room. This panel regulates operating voltages for motors on the temper mill.

Shown below is the drive for the two-high temper mill consisting of the 350-hp, 500/1000-rpm Elliott motor seen at the right, and the winding reel motor in the foreground, rated at 300-hp, 300/1090-rpm.

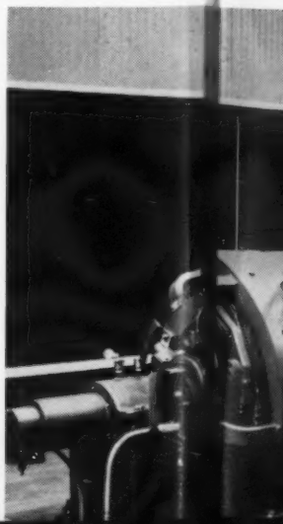


The Elliott drive for the four-high reversing mill, shown at the right, consists of a 1250-hp, 250/750-rpm motor geared to the work rolls, and two 500-hp motors for the winding reels. These motors maintain constant tension on the stainless steel strip, regardless of direction or speed. Nominal mill operating speeds are 333/1000-fpm.



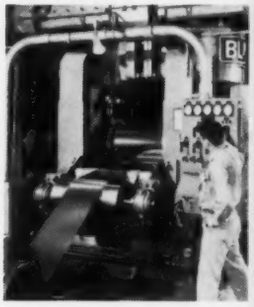


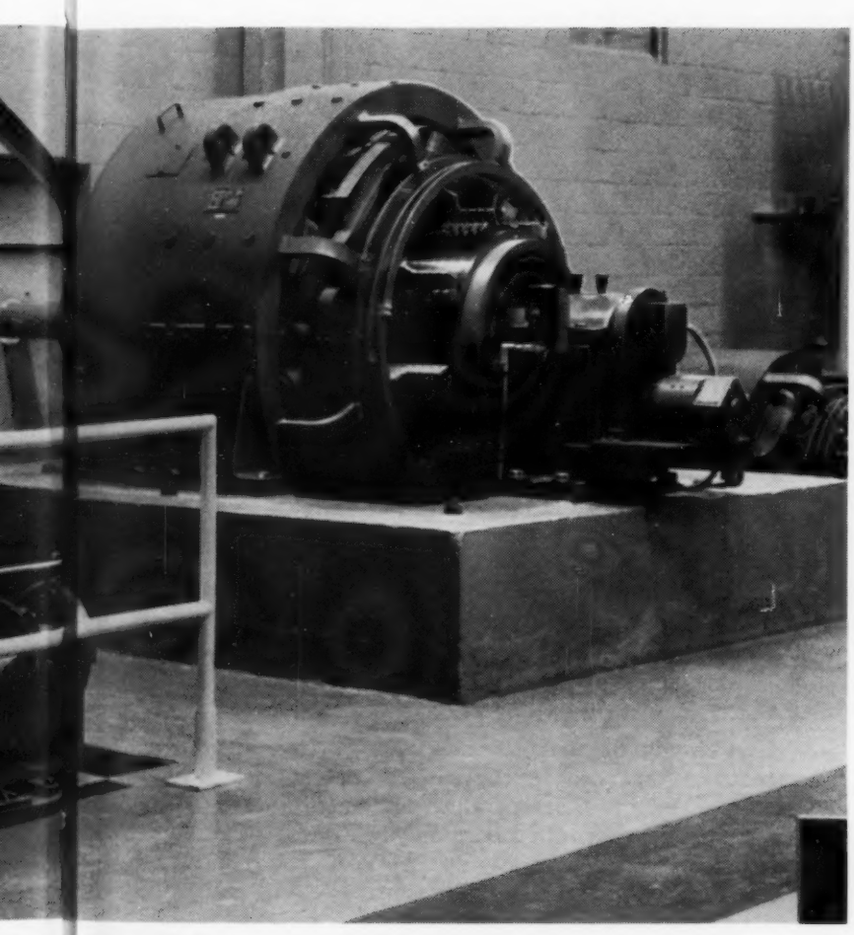
The motor-generator set at the right provides adjustable-voltage dc power for this reversing mill. It consists of a 2000-hp, 4160-v synchronous motor driving two 400-kw, 600-v generators, one 1000-kw generator, and a 30-kw, 250-v exciter. Supplying power to the temper mill driver motors is motor-generator set shown at left. Set includes 800-hp, 4160-v synchronous motor, a 15-kw exciter, and three dc generators rated respectively 100-kw, 250-kw and 300-kw.

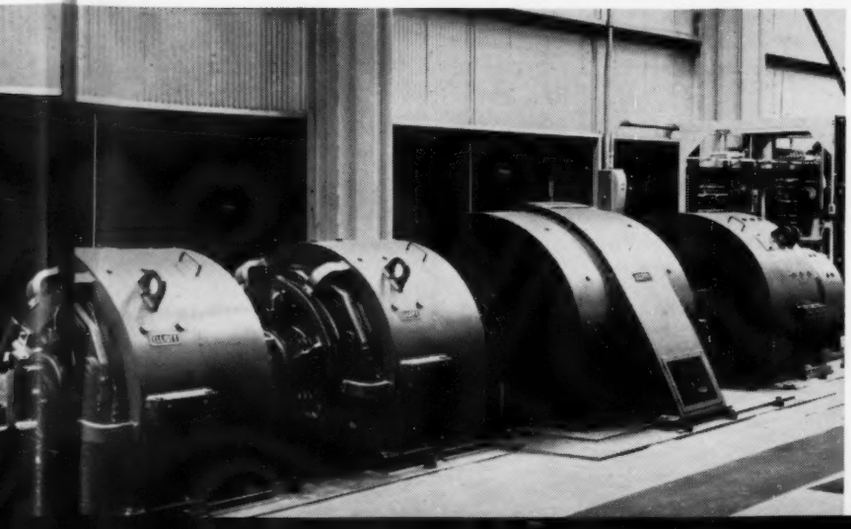


FINE REGULATION

assures perfect articulation of complex mill drives







ROLLING MILLS AT NEW UNIVERSAL-CYCLOPS STEEL PLANT POWERED BY ELLIOTT EQUIPMENT

The heart of the new processing plant of Universal-Cyclops Steel Corporation at Coshocton, Ohio, is its rolling mills. Here Elliott equipment powers the four-high reversing cold mill and the two-high temper pass mill. The equipment engineered and furnished by Elliott includes all electrical driving machinery, adjustable voltage dc control apparatus, ac control and auxiliary drivers. Some of this equipment is shown in the photographs on these pages.

Complex circuitry, dependable equipment and sound engineering are necessary to assure the fine regulation required to keep all units in perfect articulation. Elliott experience and engineering skill are reflected in the successful operation of this new mill.

Elliott is one of the leading manufacturers of large motors for steel mill drivers, and the dependability of Elliott equipment has been repeatedly demonstrated in many installations in the plants of leading producers of steel and non-ferrous metals.

ELLIOTT COMPANY

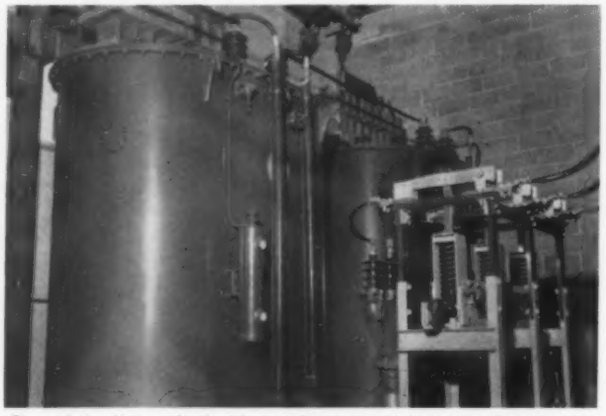
GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio; Newark, N. J.

TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS
DEAERATING HEATERS • EJECTORS • CONDENSERS • STRAINERS • TUBE CLEANERS

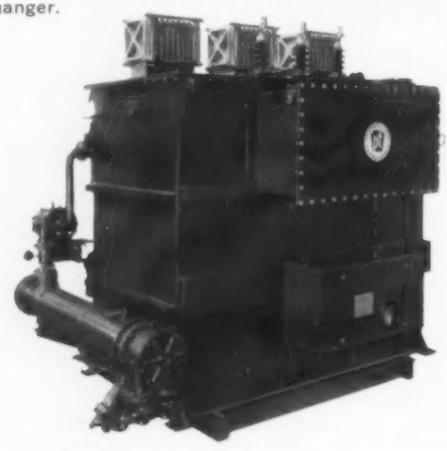
R1-10

Pennsylvania Test Transformers Take Torture Ten Thousand Times



Two of the three single-phase high-current test transformers in the Buss Fuse Test Station. Secondary short-time current capacity of over 200,000 amperes; winding connections 600, 500, 250 or 125 volts; bus connections for single- or three-phase testing.

Typical Pennsylvania Furnace Transformer below incorporates the same design principles as the test transformers at Bussmann. Rating: 6000-kva, Class FOW cooled, with motor-operated tap changer.



proves Pennsylvania furnace transformer design

Transformers in normal service may be subjected to the stresses of a short circuit once in a lifetime. But this is routine for the Pennsylvania transformers in the Buss Fuse Test Station of Bussmann Mfg. Division, McGraw-Edison Co., where tests are made daily on fuses and low-voltage switchgear.

The transformers in this laboratory may be called upon to supply short-circuit currents of over 200,000 amperes. The transformer windings and external connections must withstand the exceedingly high magnetic forces created by such values of current. Illustrating the magnitude of these magnetic forces, a test circuit with bus conductors one foot apart, supplying 200,000 amperes, can develop 14,000 pounds force between conductors, per foot of length.

Although testing with 200,000 amperes is not routine, the three single-phase transformers comprising the Bussmann test bank have been subjected to about 10,000 short circuits of current values up to their rating. This treatment has been a rugged proof-test of the basic internal design—a design which incrementally balances magnetic forces within the windings—a design originally developed and successfully applied for over ¼ century in Pennsylvania Furnace Transformers. The sizes of furnace transformers with this design have included 40,000-kva and 82,000 amperes continuous ratings.

Whether your need is special test transformers or furnace transformers, take advantage of Pennsylvania's design experience. Request a free copy of the new furnace transformer bulletin No. PFT3M960. Write for yours on your company letterhead to Power Sales Department, Pennsylvania Transformer Division, McGraw-Edison Company, Box 330, Canonsburg, Pennsylvania.

McGRAW EDISON

PENNSYLVANIA FURNACE TRANSFORMERS

Oxy-Fuel Processes Increase Steelmaking Rates

Higher and higher rates of oxygen flow and greatly increased firing rates may result in modification to the open hearth furnace to utilize its maximum capabilites.

by E. F. KURZINSKI
Manager
and R. D. Jones
Development Engineer
Applied Research and Development Div.
Air Products, Inc.,
Allentown, Pa.

BASICALLY, oxy-fuel processing is a marriage of the combustion practices of the open-hearth furnace and the faster charging and high oxygen input rates of the newer basic oxygen furnace. Results of experimental heats conducted in a number of open-hearth furnaces indicate that steel production increases of 400 per cent are possible as compared with nonoxygen, open hearth heats and increases of over 100 per cent are possible as compared with standard oxygen practices of today. While these results are encouraging, it must be emphasized that the oxy-fuel process is still in the early developmental stages and does not warrant the considerable publicity given it. Conversely discounting of the process achievements by reference to "trick heats," as has been done, is also misleading. The so-called "trick heats" made with oxygen roof lances at the Corrigan-McKinney Works of Republic Steel Corp. and other mills during the years 1946–1948 are the production practices today. It is probable that the oxy-fuel heats of today will be the production standard of tomorrow. Also, it is highly possible that tomorrow may occur sooner than the dozen years which elapsed between the development and wide-spread use of oxygen roof lancing.

The purpose of this paper is to present the latest data on oxy-fuel processing, to overcome some of the rumors which have appeared and to provoke additional thought so that the major objective is achieved, to produce more steel when desired and always at lower cost.

MAJOR FACTORS

The oxy-fuel process incorporates many factors for optimum application in addition to the controlled combustion of oxygen and hydrocarbons. These factors may be summarized as follows:

1. High-capacity burners should be used. At present, heat is supplied by use of oxygen-enriched conventional end burners complemented with the oxy-fuel jets, or oxygen-enriched conventional end burners alone. In the future, oxy-fuel jets may supply the total heat requirements, eliminating the need for conventional end burners. This will result in greater heating efficiency and added flexibility. Heat input rates will be considerably higher than the maximum firing rates used today. The combination of greater heating efficiency and increased firing rates will result in significant acceleration of the open hearth process.

2. Rapid cold material charging is a basic requirement since the high heat-input rates used with oxy-fuel processing are of maximum value only when sufficient cold material is available to absorb the energy released.

3. Immediate hot metal charging has proved highly effective in a large number of experimental heats. These heats have shown that the conventional scrap melt-down period is not necessary. Hot metal should be added immediately after completion of the cold charge, allowing a short interval for banking doors. For maximum effectiveness, the heat-input rate during charging should be such that the heat energy in the scrap, plus that available from the oxidation of the iron metalloids, is sufficient to bring the steel to tap temperature without further addition of fuel to the furnace. By charging hot metal earlier than normal, observations indicate that a portion of the hot metal temporarily freezes at the bottom of the furnace. Care should be taken when using gas forming materials such as limestone in the charge. If such material is trapped under the frozen layer, the gases evolved could be released suddenly causing a violent reaction with hazard to furnace equipment and personnel.

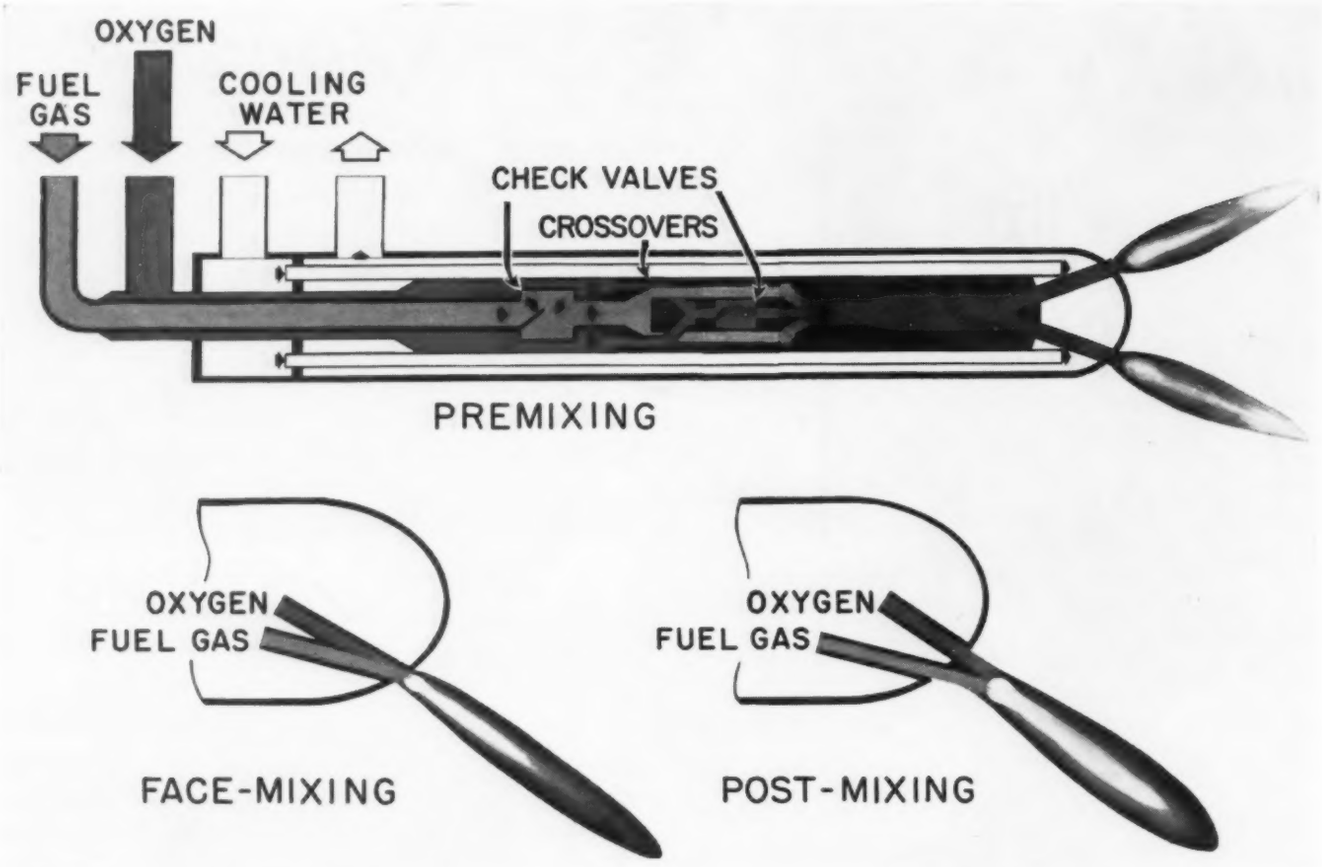


Figure 1 — Oxy-fuel jets may be designed for pre-mix, face-mix or post-mix equipment. Each method has advantages which must be considered.

4. Cold charge composition should be adjusted depending on the market value of raw materials. The high heat input rates available with oxy-fuel processing indicate that the percentages of scrap, iron ore and hot metal can be varied considerably with a minimum effect on heat time. This flexibility should result in lower material cost.

5. Injected furnace additions should be used rather than bulk additions. Iron ore, mill scale and fluxes should be injected through the oxy-fuel jets. This practice will provide excellent control of materials, decrease heat losses, and increase the effectiveness of the additions.

6. Immediate oxygen injection is of primary importance. Oxygen refining should begin immediately after the addition of hot metal.

7. Increased oxygen usage over standard oxygen practices is required. Higher oxygen flow rates, generally over 45,000 cfh per roof lance, multiple oxygen roof lances, and oxygen consumption of about 1500 cu ft per ton of steel make possible maximum steel production rates. The lances should be positioned below the slag surface to minimize slag and metal splashing.

Following all of the above procedures will provide maximum production rates. Heats resulting in substantial production increases have been made without following all of the above procedures.

Although oxy-fuel experience has been gained by a number of mills through experimental heats, adoption of these practices on a production scale in the immediate future is unlikely. This is due to the insufficient oxygen supply systems at most mills and to charging capacities which are inadequate to serve an entire shop when operating with the rapid heat times associated with oxy-fuel processing. In addition, both oxy-fuel equipment and the process itself must be refined to a greater degree before full scale operations are initiated.

HISTORY OF OXY-FUEL PROCESSING

Oxy-fuel processing had its beginnings at Granite City Steel Co. Extensive tests were being made in this mill in an effort to develop techniques to increase steelmaking rates through new methods of introducing oxygen to the furnace. Further developments in the process took place at the Ford Motor Co. More recently, other steel mills have conducted experimental heats using oxy-fuel techniques.

EQUIPMENT

Equipment for the introduction of oxygen into open hearth furnaces has been available for a number of years. Equipment to mix oxygen and fuels in the large quantities required for the oxy-fuel process is relatively unexplored. Considering the present and potential firing rates for oxy-fuel jets, it is obvious that maximum safeguards must be incorporated in the equipment.

Piping and instrumentation systems should also be designed for precise control of the oxygen and fuel gas streams. Using properly designed jets and adequate safety considerations during system installation, oxy-fuel jetting has proved to be a safe and effective method of combustion.

Jet equipment can be designed so that the oxygen-

fuel streams are pre-mixed face-mixed or post-mixed as shown in Figure 1.

Pre-mix oxy-fuel jets—The pre-mix design is suitable for those mills having relatively low natural gas pressure since the energy in the oxygen stream is used to aspirate the natural gas. Also, the pre-mix design results in improved mixing and therefore better control of the combustion products is possible. At the present time, this latter advantage is not too important. Control of the composition of the combustion products will become important, to control the oxidation of the scrap and the molten charge, at the time when all heat is introduced into the furnace using oxy-fuel flames. Finally the pre-mix system promises to make possible a central mixing station at each furnace from which mixed gases may be piped to the individual oxy-fuel jets. This would provide optimum simplicity in design and operation of oxy-fuel equipment in furnaces.

In the pre-mix design, natural gas passes through a central tube and through a check valve. The oxygen passes through an annular area surrounding the natural gas line. The oxygen and natural gas then enter the crossover; the function of this unit is to switch the gases so that the oxygen is now in the central tube and the natural gas in the annular space. The oxygen then passes through a check valve, enters the injector and aspirates the natural gas into the venturi throat. The mixed gases pass into the mixing chamber and issue out of the flame ports. This design using the crossover permits the use of check valves in the oxygen and natural gas lines.

In the pre-mix design, it is important to have the mixed gas velocity in the passages considerably greater than the rate of flame propagation to overcome pre-ignition of the combustible mixture inside the chambers. Other factors are also critical, such as the length-diameter (L/D) ratio of the flame ports. Pre-ignition is experienced if the L/D ratio of the flame ports is reduced below 1.5 to 1.

Face-mix and post-mix oxy-fuel jets—Face-mix and post-mix methods for mixing oxygen and natural gas have the advantage of minimizing flashback problems as compared to pre-mix burners. Other safety aspects must also be considered during the installation of this equipment. For example, slag freezing on the head of the face-mix unit could cause oxygen to flow into the natural gas line, or natural gas into the oxygen line causing a potential hazard. The jet design should incorporate features to prevent all such eventualities.

Mixing of the oxygen and natural gas in the face-mix and post-mix systems is definitely inferior to the pre-mix burners. A major disadvantage of the face-mix and post-mix systems is that for optimum combustion, natural gas is required at higher pressures than normally available in steel mills. Thus, for experimental trials and for subsequent production use, gas compressors are needed to provide natural gas at the higher pressures required for satisfactory burner operation. Of course, face-mixed and post-mixed burners with high-firing rates can be designed to operate at natural gas pressures of 25 psi and less, by enlarging the natural gas ports. This technique, however, results in poor mixing. In the post-mix design other fluids, such as steam, are required to maintain the natural gas ports

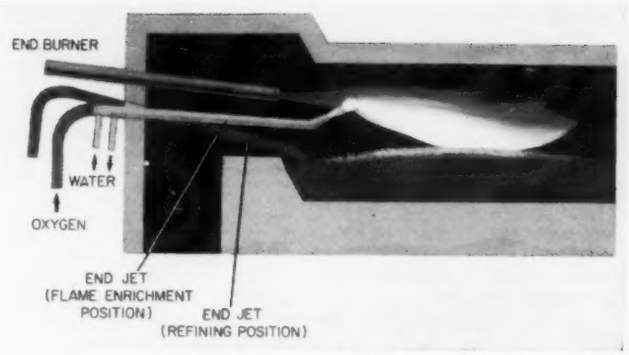


Figure 2 — Oxy-fuel jets in the end wall were investigated to develop equipment for shops having limited overhead clearances.

open when the burners are used with oxygen alone during the decarbonization period.

End jets—Oxy-fuel equipment has been installed in the open-hearth furnace through both the end walls and the roof. Figure 2 shows schematically the end jet. Installation in the end walls was investigated to develop equipment for those shops having limited head room. In addition, the direction of gas flow in the open-hearth fired with conventional end burners made it desirable to investigate the possibility of addition of oxygen-fuel mixtures through the end wall. It is known that gas velocity in the open-hearth is high, especially in the area immediately opposite the end-burner flame. It is also known that the atmosphere in the open-hearth at the incoming end is highly oxidizing. It appeared that this oxidizing, high-velocity stream would prevent metal splash from reaching the roof and would oxidize the particles as they were driven back into the bath. On this basis it seemed desirable to locate a water-cooled oxy-fuel jet immediately below the end burner. Mechanical equipment was provided so that the end jet could be moved along the burner axis and the end jet rotated as desired. In operation the end jet was reversed with the end burner.

During scrap meltdown the end jet was rotated and positioned so that oxygen alone could be directed into and at a spaced distance downstream of the conventional end-burner flame. If desired oxy-natural gas mixtures could be used.

After the hot metal was added the end jet was rotated and moved into the furnace so that the oxygen stream impinged directly onto the molten bath in the area washed by the end-burner flame.

With the silica roof and a single orifice end jet, the maximum oxygen input rate was limited to about 30,000 cfh. Using 40,000 cfh and locating the oxygen "boil" behind the flame, large volumes of iron oxide fume resulted. Since the end-burner flame could be considered a solid, this iron oxide concentrated along the skewback and resulted in premature failure of the silica roof. At 20,000 cfh and locating the "boil" in the flame resulted in essentially the same roof life as with conventional roof lance practice. Results obtained using the single orifice end jet are shown in Table I. These results are compared with the results obtained on the same furnace with open hearth roof lances.

Following the conclusion of the single orifice program, a three-orifice end jet was fabricated. This unit was made to more completely study the addition of

TABLE I
Comparison of End Jet and Roof Lance Practice

Process	End jet 20,000 cfh	End jet 40,000 cfh	Dual roof lance 25,000 cfh each
Production rate, net, tons per hour	30.09	34.38	28.91
Fuel consumption, Btu per ton steel	3.57	3.09	2.71
Decarb oxygen, cu ft per ton steel	220	383	832
Tap carbon, per cent	0.07	0.07	0.07

oxygen and fuels into an open-hearth from the furnace end walls. This unit was installed on another furnace having a basic roof. After a brief period of operation, these jets failed because of insufficient cooling water. The program investigating end jets was then postponed to permit emphasis on the addition of oxygen and fuels through roof jets.

ROOF JETS DURING MELTDOWN PERIOD

Initially oxy-fuel roof lances had six flame ports and operated at 12,500,000 Btu per hr. The angle of the flame ports on these units was 20 degrees from the vertical. It soon became apparent that the flame port angle should be increased to melt down a larger area of scrap. These initial trials showed that the high temperature and the scrubbing action of these flames resulted in considerably more effective heat transfer to the cold material than is possible with conventional burners. Present burners have a flame port angle of 30 degrees from the vertical and melt an area 8 to 10 ft in diameter. This appears to be the maximum desirable angle since a further increase in the flame port angle would minimize the jets effectiveness when operated with oxygen alone during the refining period. Jet capacity was also increased to 30,000,000 Btu per hr.

After these initial trials two oxy-fuel jets were installed in a 400-ton open-hearth furnace. It was determined that the most effective lance height for scrap meltdown was 3 to 4 ft above the scrap. Using a greater jet height (7 to 9 ft), a larger area was heated; however, the heating efficiency was noticeably reduced. When the jet was positioned closer to the scrap (one ft above the scrap), melting took place rapidly; however, only a small area was melted. Also, at the lower jet height, small particles of molten metal were blown against the roof and walls of the furnace.

Oxygen natural gas ratios of 1 to 1 to 2 to 1 were studied. Most effective heating occurred at ratios between 1.5 to 1 to 2 to 1, depending on the condition of the scrap. The oxy-fuel jets were used during the scrap charging period and during the meltdown period following the scrap charge. While the furnace was being charged, the jets were operated 3 to 6 in. below the roof cooler to avoid damage by the charging boxes. Although heating efficiency at this height was not as great as when the jets were positioned 3 to 4 ft above the scrap, furnace trials showed that it was definitely advantageous to operate the jets during charging in order to expose all of the scrap in the furnace to the high-temperature flames. After the furnace was completely charged, the jets were lowered to the normal operating height and run until the last hot metal addition was made. When hot metal delays were encountered and the jets allowed to operate for extended periods of time, they melted all the scrap in an 8 to 10 ft diam to a depth of approximately 3 to 4 ft in about one hr. In subsequent trials two additional oxy-fuel jets were installed to obtain better flame coverage of the hearth area and, therefore, more uniform scrap heating. After the addition of hot metal the gas is turned off. The lances are then lowered to approximately 6 in. above the slag-metal interface with an oxygen flow rate of approximately 45 to 70,000 scf per hr per lance. The first noticeable furnace reaction is the formation of a foamy slag which remains foamy throughout and performs the function of minimizing slag and steel splashing onto the furnace roof and walls.

Since the oxy-fuel process drives sufficient heat into the scrap before hot metal addition, the jets may be operated with oxygen alone during the refining period. Under certain conditions, where additional heat is required with minimum decarbonization, fuel may be reintroduced with the oxygen to create a flame which is essentially neutral to the metalloids in the steel.

RESULTS WITH OXY-FUEL PRACTICES

Results obtained using oxy-fuel practice in which roof burners supplement conventional end burners are shown in Table II. Table III shows the results without roof burners and conventional meltdown period, but with quick charging and high oxygen consumption and flow rates. These heats are among the first to be made using oxy-fuel principles; therefore, the results should improve as present techniques are improved.

The data presented in Tables II and III represent average results for heats made in six separate shops. Since each shop is innately different from the others with regard to furnace performance and efficiency, the results show some variance. An example of this is evident in Table III where, in one shop, a substantial increase in steel production was effected in a 300-ton furnace by increasing oxygen consumption from 404 cu ft per ton to only 645 cu ft per ton of steel. Within any one shop, however, the results of a series of oxy-fuel heats show a unique consistency and predictability. For example, in one shop tap-to-tap time for a series of five oxy-fuel heats showed a variance of only 3.3 per cent. The predictability of oxy-fuel heats will permit closer scheduling and, therefore, more effective use of open-hearth equipment. Also, the consistency of the operation brings open-hearth automation considerably closer than was previously thought possible.

Comparing the results, it may be seen that production rate increases varied from 75 to 380 per cent as compared with existing practices using oxygen roof lances. These increased production rates were accompanied by a decrease in fuel consumption ranging from 14 to 72 per cent as compared to previous oxygen practice. In fact, heats have been made with a fuel consumption of less than 800,000 Btu per ton of steel. Total oxygen consumption showed an increase ranging from 40 to 400 per cent over conventional oxygen roof lance practice. Though the oxygen consumption is relatively high in oxy-fuel heats, normally, the savings effected in fuel alone more than cover the cost of the additional oxygen.

It should be noted that oxygen was introduced to the furnace at high flow rates. Although normally, roof

TABLE II

Comparison of Standard Oxygen and Oxy-fuel Practices Using Roof Burners

Furnace size, tons	Number of oxygen lances	Oxygen flow per lance, scf per hr	Production rate charge to tap, tons per hr	Oxygen consumption, scf per ton	Fuel consumption, mm Btu per ton	Furnace Cycle			
						Charge to tap, hrs:min	Start charge to finish charge, hrs:min	Finish charge to finish hot metal, hrs:min	Finish hot metal to tap, hrs:min
① 200	2	50,000	63.9	1678	1.56	3:03	0:22	0:19	2:22
200	2	30,000	36.1	1083	1.82	5:42	0:58	1:40	3:04
① 400	4	40,000	76.7	1998	1.30	5:16	0:47	0:36	3:53
400	2	30,000	34.8	740	2.09	11:15	2:35	2:05	6:35
① 450	3*	80,000	152.5	1603	1.01	2:50	0:20	0:30	2:00
450	2	30,000	31.7	675	2.82	13:26	3:12	2:32	7:42

* 2 Oxygen lances; 1 roof burner.
① Oxy-Fuel Heats

TABLE III

Comparison of Standard Oxygen and Oxy-fuel Practices Using No Roof Burners

Furnace size, tons	Number of oxygen lances	Oxygen flow per lance, scf per hr	Production rate charge to tap, tons per hr	Oxygen consumption, scf per ton	Fuel Consumption, mm Btu per ton	Furnace Cycle			
						Charge to tap, hrs:min	Start charge to finish charge, hrs:min	Finish charge to finish hot metal, hrs:min	Finish hot metal to tap, hrs:min
① 200	2	70,000	75.8	1874	1.03	2:47	0:25	0:30	1:52
200	1	41,000	28.3	375	3.63	7:54	1:58	3:44	2:12
① 200	2	42,000	56.5	1005	1.32	3:45	0:50	0:45	2:10
200	2	25,000	26.2	718	2.73	8:18	2:36	1:30	4:12
① 300	2	46,000	82.3	645	1.29	3:53	0:52	0:49	2:12
300	2	20,000	43.8	404	2.40	7:20	1:57	1:35	3:48
① 400	4	40,000	88.6	1667	1.01	4:41	0:47	0:38	3:16
400	2	30,000	34.8	740	2.09	11:15	2:35	2:05	6:35
① 500	2	45,000	53.6	850	2.03	9:38	2:17	2:46	4:35
500	2	25,000	25.2	542	3.70	17:17	5:12	5:08	6:57

① Oxy-Fuel Heats

damage would result from such a practice, close observation indicated no noticeable increase in roof deterioration. To date oxy-fuel heats have not been made for a full campaign; therefore, roof life data are, as yet, inconclusive. It is anticipated that these data will be available in the near future.

Evaluation of the data shown in Tables II and III shows the wide variance in open hearth results from different shops. Indications are that a charge-to-tap time of about three hr is the lowest possible with present charging and pit-side facilities without causing a major increase in oxygen consumption per ton of steel with no compensating increase in steel production. In fact, it is to the advantage of the steel mill to undertake a test program to investigate the gain in steel production using oxy-fuel techniques at a range of oxygen consumptions to determine the most economical level of steel production.

From the experience developed to date, it seems that improved and faster charging techniques will be necessary prior to obtaining maximum benefits from oxy-fuel processing in open-hearth furnaces, especially where roof burners are used.

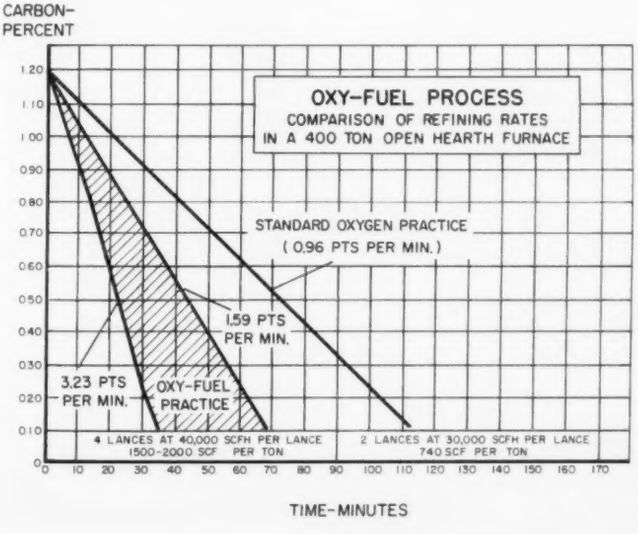
Of significance is that steel production rates were increased significantly in every case where oxy-fuel practices were tried. The increase was not difficult to ascertain as is the case with combustion oxygen. In Table III the data on the 500-ton furnace represents only one heat, and in this case a shop record was made although a three-hr delay occurred during the heat.

The higher oxygen flow rate used during the decarbonization period is a major reason for the substantial increase in steel production rate. Figure 3 compares the carbon reduction rate during the refining period for the oxy-fuel heats and standard oxygen heats. With newer equipment it can be expected that these carbon reduction rates will be exceeded.

SUMMARY

Purpose of the present programs is to develop information on potential production rates of open hearth furnaces and to determine the economics of processing steel using large quantities of oxygen and fuel. To implement this program pre-mix, face-mix and post-mix burners having firing rates considerably in excess of present burners are being developed. The

Figure 3 — Higher oxygen flow during the decarbonization period is a major factor for the increase in the production rate.



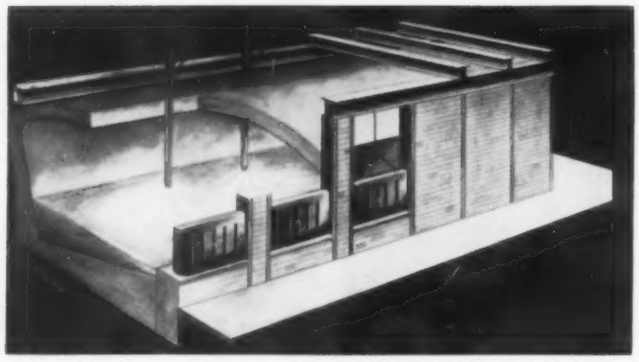


Figure 4 — A modern open hearth furnace may be designed with four oxy-fuel roof lances to be used for meltdown or heat pickup or on oxygen alone after the hot metal addition.

upper limit will be the ability of steel to absorb heat and not the limitations of the furnace geometry.

A future major benefit of oxy-fuel processing will be the predictability of open hearth operation. This will change the furnace from operation by art to operation by science. The result will be the operation of open hearths by the clock, similar to present LD practices.

Oxy-fuel techniques may result in modification of the present open hearth. Introduction of all fuel through the furnace roof could result in reduction or elimination of the checker system. In this case, the combustion products may be used to preheat scrap. Figure 4 shows what might be a modern open hearth of the future. This furnace is serviced with four or more oxy-fuel lances. For scrap meltdown and for heat pickup when desired, the roof lances would be used with oxygen-fuel mixtures. Immediately after hot metal, the fuel would be turned off and oxygen used alone.

More importantly, oxy-fuel lances could have considerable advantages in basic oxygen furnaces, as shown in Figure 5. The LD converter at the present time is limited to about 30 per cent scrap in the charge, depending upon the chemistry of the hot metal. By the application of heat through an auxiliary flame, the scrap charged into the LD vessel could be varied depending upon the relative price of scrap and hot metal.

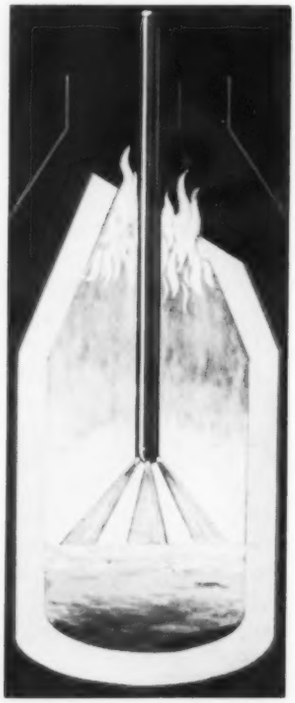


Figure 5 — Oxy-fuel lances could increase the advantages of the LD process by permitting greater scrap meltdown percentages and allowing heat additions when desired.

Oxy-fuel jets should be considered as a tool, the same as the oxygen lance. The oxy-fuel jets provide extremely high temperatures and heat releases which will find uses in steel and other metallurgical applications. Experimental tests on blocks of steel indicate that heat-input rates into steel can be markedly increased over present open hearth practice without decreasing heating efficiency; heating efficiency being defined by the ratio of Btu's adsorbed by the steel versus Btu's available in the fuel gas.

Oxy-fuel processing can effect changes in open hearth practices and geometry. To make possible the production capabilities, improved charging is necessary. To use even higher oxygen flow rates, the roof may have to be raised or maybe removed. Using oxygen, the checkers may be removed because of the lower quantity of combustion products or because of the large quantity of oxide fumes. Figure 6 shows a possible evolution of the open hearth. After considering this evolution the question remains though, how long should the steel industry prolong the life of the open hearths when the technical and economic conditions are proven for oxy-fuel practices in the converter-type vessel: a vessel more suited to utilize higher oxygen flows? This question may have to be answered sooner than many operators care to realize.

Discussion

PRESENTED BY

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A. L. Hodge: Probably the most outstanding new accomplishment in the open hearth furnace is an almost precise degree of predictability. This has been brought about with far greater thermal and chemical driving forces made available with oxygen and better refractories. This new degree of control and prediction can be compared with the precision of the electric furnace, pneumatic processes, or simply baking a cake.

Moreover, this new degree of predictability has permitted fantastic production rates of 125 to 150 tons per hr on furnaces struggling to make 25 or 30 tons per hr only a few years ago.

At these high production rates using hot metal changes of 40 to 60 per cent, thermal efficiencies have reached 70 to 75 per cent compared with a normal efficiency of 25 per cent or so. This, of course, reflects itself in fuel consumption of about a million Btu per ton or less.

Along with these high driving rates the open hearth is still a very highly efficient oxidizing process. For example, during a recent heat made at a rate of over 150 tons per hr, about 35 per cent of the total chemical oxygen absorbed by the bath was supplied from the furnace atmosphere.

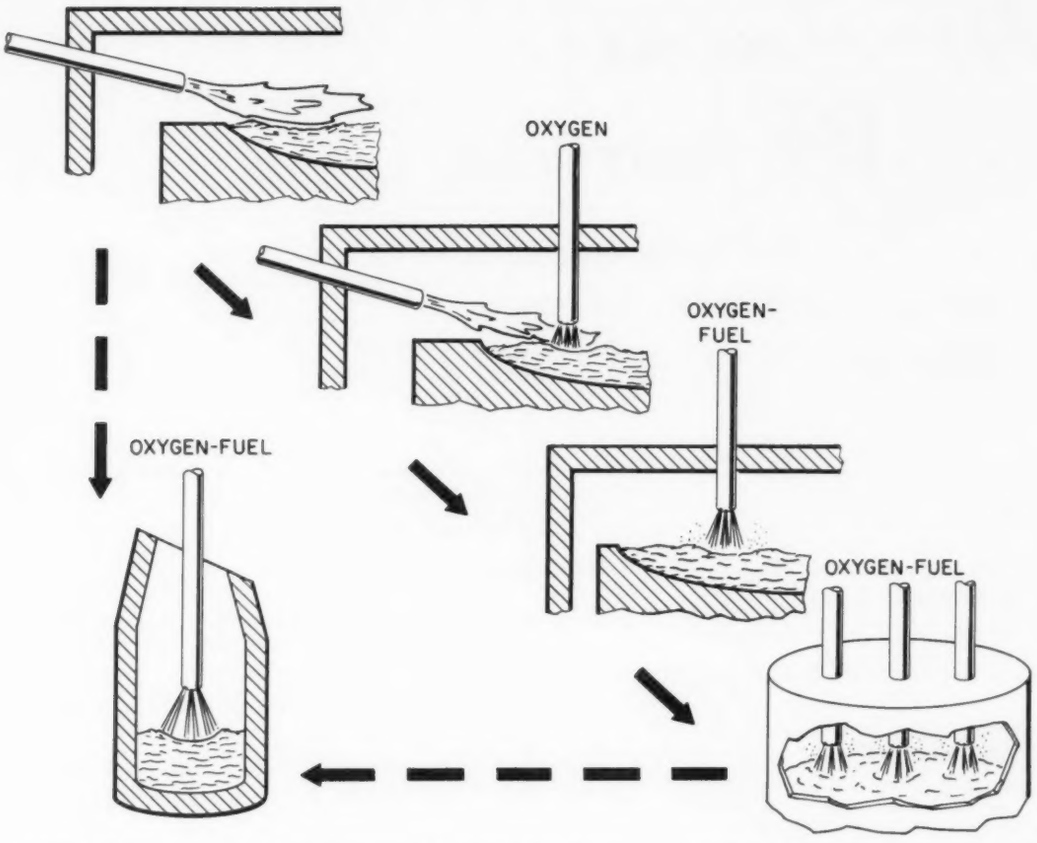


Figure 6 — The evolution of the open hearth furnace may result in a vessel more suited to the utilization of higher oxygen flows required for significant increases in production rates.

Another very worthwhile accomplishment has been in evaluating the relationship of firing rate, charging time, and cold charge materials when making very fast heats. This provides an excellent guide in how best to supply early heat to the charge particularly in using combustion oxygen, special burners, etc. This relationship may be written as:

$$FR = \frac{500\ M + 1000\ L + 2000\ R}{te}$$

In which:

FR = Total firing rate, Btu per hr
M = weight of cold metal, lb
L = burnt lime plus ore charged, lb
R = raw limestone, lb
t = time from start charge to finish hot metal, hr
e = per cent of time, t, fuel is on

As an example on the use of the above relationship let us assume the following:

1. Furnace size = 350 tons
2. Hot metal = 50 per cent
3. Tap carbon = 0.10 per cent
4. Total charge time = 1.5 hr
5. Charge: 350,000 lb scrap, 350,000 lb hot metal, 24,000 lb limestone, 12,000 lb burnt lime and 15,000 lb charge ore.
6. Total time fuel on from start charge to finish charge = 90 per cent.

The problem is to calculate the firing rate for the hot metal addition within 1.5 hr total charge time, and determine the lance oxygen input rate for heat time of 5 hr, charge to tap (70 tons per hr).

The solution is: from the above relationship, the firing rate should be about 185,000,000 Btu per hr, which from a previous report[1] is an oxygen input rate for a 3.5-hr blowing period of 100 cfhr per ton or 35,000 cfhr.

So much for the accomplishments. There still remains much work to do and questions to be answered such as:

1. How can the open hearth be charged more rapidly?
2. During high blowing rates should the combustibles be burned in the furnace or expelled to the atmosphere?
3. Should checkers be modified and how?
4. How can smoke and fume be controlled most effectively and economically?
5. Are the new ideas on burners, lances and gadgets safe, economical and simple?

Regarding safety in the design and operation of oxy-fuel burners and jets, let us not slip over this aspect lightly. One fact to always remember is: "Knowing is not enough."

Now you showed data for a heat made at 152.5 tons per hr and a footnote stating two jets and a roof burner were used. Since your paper was primarily concerned with the development of equipment, we take pride that those three pieces of equipment were our units.

E. F. Kurzinski. Our purpose was to present to the steel industry all of the information on the oxy-fuel practice which was available at the time of the paper. After release of the information on the experimental work which was conducted initially at Granite City and Ford, a number of equipment manufacturers undertook construction of oxy-fuel jets for open hearths.

BIBLIOGRAPHY

1. "How Oxygen Input Affects Steelmaking Rates," Journal of Metals, Figure 2, p. 326, April, 1960. ▲

PROGRAM

AISE Western Meeting

The Statler Hilton
Los Angeles, California
February 27, 28, and March 1, 1961

MONDAY, FEBRUARY 27

8:30 am—REGISTRATION—
Foyer-Ball Room Floor

9:00 am—TECHNICAL SESSION—
Sierra Room

Chairmen: S. F. Mazur, Electrical Superintendent, Pacific States Steel Corp., Niles, Calif.

Harry Riegel, Superintendent of Utilities, Iron & Steel Div., Kaiser Steel Corp., Fontana, Calif.

"Automation and Process Control in Soviet Iron and Steel Industry," by W. E. Miller, Manager, and R. M. Sills, Application Engineer, Metal Rolling & Processing Engineering, Industrial Engineering Operation, General Electric Co., Schenectady, N. Y.

"The Power Distribution System of an Integrated Steel Plant," by Donald Stewart, Jr, Electrical Maintenance Engineer, Electrical Maintenance Dept., Kaiser Steel Corp., Fontana, Calif.

"Outstanding Application Developments in Mill Electric Drive Systems," by W. H. Dauberman and S. V. Stickler, Jr., Sponsor Engineers, Metal Working Section, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

2:00 pm—TECHNICAL SESSION—
Sierra Room

Chairmen: Louis E. Ringger, Assistant to General Superintendent, Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

J. B. Wylie, General Superintendent, Judson Steel Corp., Oakland, Calif.

"Ceco's Ochiltree Works Modern Electric Furnace Bar and Merchant Mill," by W. B. Jacobsen, Works Manager, Ochiltree Works, Ceco Steel Products Corp., Lemont, Ill., and Lawrence S. Barker, Jr., Project Manager, The Rust Engineering Co., Birmingham, Ala.

"The Rolling of Ultra-Thin Tinplate," by Dr. M. D. Stone, Manager, Development, United Engineering and Foundry Co., Pittsburgh, Pa.

"The Story of Atlantic City," by W. F. Pruden, Chief Engineer, Columbia-Geneva Steel Div., United States Steel Corp., San Francisco, Calif.

World-famous Wilshire Boulevard crossing MacArthur Park, with downtown Los Angeles in the background.

TUESDAY, FEBRUARY 28

9:00 am—TECHNICAL SESSION—
Sierra Room

Chairmen: Jerome L. Lindberg, Superintendent of Mechanical Dept., Pueblo Plant, The Colorado Fuel and Iron Corp., Pueblo, Colo.

R. J. Tremblay, General Manager, Pacific Coast Div., Bethlehem Steel Co., Los Angeles, Calif.

"Solutions to Basic L-D Plant Layout Problems," by J. W. Irvin, Senior Project Engineer, Kaiser Engineers, Div. of Henry J. Kaiser Co., Oakland, Calif.

"Natural Gas Injection into the Blast Furnace at Lone Star Steel Co.," by Fred W. Farmer, Combustion Engineer, and J. C. Moreland, Junior Combustion Engineer, Lone Star Steel Co., Lone Star, Texas

"Oxy-Fuel Processes Increase Steelmaking Rates," by E. F. Kurzinski, Manager, and R. D. Jones, Development Engineer, Applied Research and Development Div., Air Products, Inc., Allentown, Pa.

2:00 pm—TECHNICAL SESSION—
Sierra Room

Chairmen: R. L. Dowell, Superintendent Cold Reduction, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

W. L. Murphy, Assistant General Manager, Pacific Coast Div., Bethlehem Steel Co., South San Francisco, Calif.

"The Production and Uses of Aluminized Steel," by John D. Sprowl, Research Engineer, Dept. of Metallurgical Research, Kaiser Aluminum & Chemical Corp., Spokane, Wash.

"Use of the Open Coil Process to Change Composition and Produce Improved Sheet Steels," by John A. Bauscher, Vice President—Research, Lee Wilson Engineering Co., Inc., Cleveland, Ohio.

"The Application of a Non-Contacting Measurement System for Coating Weights on Continuous Galvanizing Lines," by James E. Reider, Area Manager, Industrial Nucleonics Corp., Columbus, Ohio

7:00 pm—INFORMAL STAG DINNER—
Pacific Ball Room

Speaker: H. C. McClellan
"The Outlook for Business"

WEDNESDAY, MARCH 1

8:30 am

Inspection Trip to Fontana Works of Kaiser Steel Corp. Buses will leave The Statler Hilton at 8:30 am

hotel reservations

Write direct for hotel reservations to The Statler Hilton, Los Angeles, Calif., giving time of arrival and type of accommodations desired. Reservations should state that they are for AISE Western Meeting.

transportation

Individuals or groups desiring assistance in planning their trip should get in touch with the office of American Express Co., in their respective cities or with any local travel agency.

Western Meeting Chairmen

S. F. MAZUR

J. L. LINDBERG

HARRY RIEGEL

R. J. TREMBLAY

L. E. RINGGER

R. L. DOWELL

J. B. WYLIE

W. L. MURPHY

Abstracts of Technical Papers

to be presented at

AISE WESTERN MEETING

February 27, 28 and March 1, 1961

THE STATLER HILTON LOS ANGELES, CALIF.

"AUTOMATION AND PROCESS CONTROL IN SOVIET IRON AND STEEL INDUSTRY"

by W. E. MILLER, Manager, and R. M. SILLS, Application Engineer, Metal Rolling & Processing Engineering, Industrial Engineering Operation, General Electric Co., Schenectady, N. Y.

W. E. MILLER

R. M. SILLS

△LAST summer Mr. Miller spent 11 days in Russia, and Mr. Sills spent a like amount of time in Czechoslovakia. Both men attended technical meetings devoted to problems of the iron and steel industry, visited plants and had discussions with numerous engineers from Russia and the other countries of the East. The paper describes some of what they saw and heard, and discusses many of the differences between the Soviet approach and that of the West.

The U.S.S.R. has placed its economic future in the hands of automation and the systems engineer. This extreme concentration on the development and application of advanced automation theory and techniques is expected to raise product quality and productivity of the individual worker to levels surpassing that of the western world, according to Soviet engineers. This goal is not expected to be achieved over night, nor within a year. In the steel industry this time may be five to ten years away.

The situation in Czechoslovakia is similar, although they do not have as far to go. Their steel production has more than doubled since before the war, and is planned to double again by 1965. This could put their per capita production above ours.

The paper also describes some of the automation work that has been done behind the iron curtain, and the present status of it in those countries.

In addition, a description of the newest and most modern steel mill in Czechoslovakia is included.

"THE POWER DISTRIBUTION SYSTEM OF AN INTEGRATED STEEL PLANT"

by DONALD STEWART, JR., Electrical Maintenance Engineer, Electrical Maintenance Dept., Kaiser Steel Corp., Fontana, Calif.

DONALD STEWART, JR.

△THE electrical power distribution system of a steel plant is the "heart and blood" of the physical installation which is necessary to produce steel. Weaknesses or failures in the system produce effects in the steel plant similar to circulatory malfunctions or breakdowns in the human body. Therefore design, installation and maintenance of such systems should receive careful consideration and action by anyone concerned with maximum continuity of high quality electric service.

The power distribution system of the Fontana plant of the Kaiser Steel Corp., through the years of operation and expansion of the plant, has had to be considered from such a point of view. The system is described in the paper as it exists now, and in the forms which it has had and progressed through since the start of plant operation in 1942.

Certain design and maintenance factors will either create and accentuate, or minimize and eliminate, problems connected with the continuous and satisfactory operation of a steel plant power system. These factors are discussed and related to the operation of the system and the plant at Fontana. Some of the design factors were not considered carefully enough

in the original construction or later extensions of the system. Resulting inferior operation of portions of the system, affecting the quality of the plant operation, necessitated reconsideration. Actions were initiated to correct the undesirable conditions generated by original lack of proper regard for all the factors. The preventive and remedial actions taken at the Fontana plant to produce a high quality operating system are described.

As the system has evolved and expanded, in addition to the increase in size and quantity of components of the system which is to be expected, the form and structure of the system almost always has improved until today it might be called a model of a well-balanced, flexible, continuously functioning, almost trouble free system.

"CECO'S OCHILTREE WORKS MODERN ELECTRIC FURNACE BAR AND MERCHANT MILL"

by W. B. JACOBSEN, Works Manager, Ochiltree Works, Ceco Steel Products Corp., Lemont, Ill., and LAWRENCE S. BARKER, JR., Project Engineer, The Rust Engineering Co., Birmingham, Ala.

W. B. JACOBSEN

L. S. BARKER, JR.

Δ FOR the past few years Ceco Steel Products Corp. had seen their need growing for a firm source of steel, which source would by necessity be their own production mill. As a result of this, in February, 1958, Ceco contracted for design and construction of a complete new steelmaking facility, to be located near the village of Lemont, Ill.

Basic criteria used to develop production capacity for the new plant was Ceco's steel consumption. The plant was originally planned to produce 110,000 annual tons of standard size reinforcing bars, angles and merchant shapes. Based on this production requirement, the original plant layout included two, 20-ton per heat capacity, electric-arc furnaces for billet size ingot production, and rolling mill specification was for equipment designed to produce slightly more than basic required tonnage. The rolling mill as actually installed was, however, capable of producing considerably higher tonnage than originally contemplated; therefore a third 20-ton capacity furnace was added to the melt shop with resultant plant potential at 180,000 annual tons.

Construction began in July, 1958, the first activity being on the melt shop foundations. Melt shop portion of the project was pushed to completion in late March, 1959, with the result that first ingots were cast in early April, 1959. Melt shop operations began on a one-crew, 5-turn per week basis. As furnace operators were trained both furnaces were placed in operation, and the number of turns increased to 20 per week. In March, 1960, the third furnace was placed on the line and currently the entire melt shop is on a 20-turn basis. Even with the relatively green operating crew, the Lemont furnaces are now producing over 12,000 tons per month of billet size ingots.

Rolling mill building construction began in November, 1959; and, despite severe winter weather and late equipment deliveries, the mill was completed and placed in operation by late August, 1960. Rolling mill together with ingot reheating furnace began operations on a 5-turn per week basis. As in the case of the melt shop, additional crews were trained and the mill now operates on a 12-turn per week basis with production well over 1000 tons per month.

The 14-stand rolling mill is fully automated for high tonnage production with a minimum of manpower required. Though the mill is automated, it is also designed to allow quick, economical production changes as required by the rolling schedule.

Transportation-wise, the plant site is ideally located between a main line railroad and the Chicago Sanitary and Ship Canal and further the plant is connected by good roads to a main highway net.

The transition from construction into operation has been smooth and the facility has been operated on a profitable basis since shortly after the first steel was rolled.

"THE ROLLING OF ULTRA-THIN TIN PLATE"

by DR. M. D. STONE, Manager, Development, United Engineering and Foundry Co., Pittsburgh, Pa.

DR. M. D. STONE

Δ THE paper considers an impending major advance in the tin plate field, the rolling and production of ultra-thin tin plate, a product ranging from 60 to 30 lb per base box (0.0062 to 0.0031 in.). The paper considers various possibilities of accomplishing the objective, with relevance to the economics involved, as the primary objective is a cheaper product, that will enable tin plate to hold its pre-eminent place in container manufacture, against the ever quickening competition of aluminum, glass and paper.

Various approaches are discussed in some detail, including: the advantages of the 6-stand tandem cold mill over the widely used 5-stand mill for rolling down to final gage; the pros and cons of a post-rolling operation in the hard state after conventional 5-stand rolling; the possibilities of rolling "double" strip as is practiced in the aluminum foil field; questions regarding rolling twice through the 5-stand with a suitably selected intermediate anneal; etc. The handling problem of this very thin product undoubtedly will bring innovations, such as the use of sleeves, common in the aluminum foil industry; or a combined continuous annealing and tempering operation, to avoid handling in the annealed state, etc. Temper rolling will require smaller work rolls.

An analysis of this subject, which pointed up reasons

why a cheaper product could be produced, when it was started about a year ago, also discusses the matter of rolling a somewhat modified product that is currently being given a great deal of thought and research, a very thin but at the same time a very hard product achieved primarily by rolling. This product which has already appeared on the commercial scene at an attractively lower price, may be produced by a final cold rolling reduction of the conventionally produced coils of electrolytic tin plate, followed by a suitable cleaning and passivating operation, or by substituting a heavy cold reduction operation for the conventional temper rolling operation. The problem of product flatness will tend to become more difficult, and the use of instantaneous-crown-controlled mills is offered as an aid in this direction. It is felt that the economic production of this ultra-thin product will be achieved much sooner than is being generally prophesied.

"OUTSTANDING APPLICATION DEVELOPMENTS IN MILL ELECTRIC DRIVE SYSTEMS"

by W. H. DAUBERMAN and S. V. STICKLER, JR., Sponsor Engineers, Metal Working Section, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

W. H. DAUBERMAN

S. V. STICKLER, JR.

△ NEARLY all phases of the metal working industry have participated in the recent developments in mill drive systems. They begin at the stock house and blast furnace and extend to the finishing mill and process lines where operations are now being performed with a greater degree of automation to produce higher quality and more uniform products. On many of the recent drive systems the control is predominantly of the static type with on-line computers playing an important role. Digital control systems have been applied for many positioning systems such as a crane operator controlled ingot buggy.

Automatically controlled primary mills such as blooming and slabbing mills, reversing roughing mills and plate mills using punched card programming is now well accepted. The newest development is the addition of an on-line computer to calculate and program a schedule for every ingot or slab using rolling equations. The only instructions supplied to the computer are incoming product dimensions, product character and desired final dimensions. The computer continually monitors the operation compensating for any deviation of actual results from calculated values.

The hot strip mill has become the object of a concentrated development effort in order to improve its performance. The addition of speed regulators has been shown to improve the gage characteristics of the strip while automatic gage control systems working in conjunction with the speed regulators operate to provide a more positive control of gage. These systems employ high speed electrohydraulic screwdowns, tension regulating loopers, load cells and x-ray gaging equipment operating to correct for such conditions as skid marks and temperature run down.

Cold reduction mills are now using more advanced static control systems as a result of the introduction of the transistor controlled rectifier and static switching. A computer has been used to calculate the proper inertia compensation to apply to reel drives when accelerating coils of various widths and diameters.

"THE STORY OF ATLANTIC CITY"

by W. F. PRUDEN, Chief Engineer, Columbia-Geneva Steel Div., United States Steel Corp., San Francisco, Calif.

W. F. PRUDEN

△ ON June 30, 1960, ground was broken for the construction of facilities to mine, concentrate and agglomerate iron ore from the properties of the Columbia-Geneva Steel Div. of United States Steel Corp. near the old ghost mining town of Atlantic City, Wyo. The pelletized product from this source will be shipped to blast furnaces at the Division's Geneva Works at Provo, Utah.

The iron formation at Atlantic City is quite similar to the magnetic taconites of Minnesota. Experience gained there facilitated translation of test data to projected plant practice. Preliminary engineering was started in 1956. Bulk samples of ore were processed through pilot plant tests to develop the optimum plan for mining, the number of crushing stages, the mesh of grind, types and sizes of mills required, and the specifications for concentrating and filtering equipment. Of major importance was the selection of the best agglomerating method to suit all of the conditions requiring consideration.

Numerous service problems needed extensive investigation and engineering study to assure a complete and efficient operating unit in a relatively remote area. The essential commodity, water, is scarce in this location. Development of adequate sources of supply, proper conservation and reuse posed many problems.

Electric power and fuel sources had to be developed, and transmission facilities provided to bring these essential utilities to the plant location from outside areas.

Since the main railroad to Geneva Works was 76 miles away at its closest point, it was necessary to plan and build a railroad connection from Winton Junction near Rock Springs, Wyo., to the Atlantic City plant site.

In addition to these service problems, there were many factors peculiar to this location which required attention in the development of engineering plans. Winter weather in this area is severe. The problems of high winds and low temperatures had to be dealt with in all design decisions. The plant is at an elevation of 8300 ft. The effect of the thinner air at this elevation was a significant consideration in the design

of vacuum filters, selection of fan sizes and overall energy requirements for the plant.

Location and weather were also major factors in developing the construction schedule. Certain work could only be accomplished during periods of low run-off in streams or when temperatures were above freezing. This dictated close adherence to a detailed construction plan to permit completion in the shortest feasible period of time. Plant site construction photographs show the satisfactory progress which has been made into the winter period 1960–1961.

"NATURAL GAS INJECTION INTO THE BLAST FURNACE AT LONE STAR STEEL CO."

by FRED W. FARMER, Combustion Engineer, and J. C. MORELAND, Junior Combustion Engineer, Lone Star Steel Co., Lone Star, Texas

F. W. FARMER

J. C. MORELAND

Δ LONE Star Steel Co. is located in northeast Texas, in close proximity to natural gas production. Since 1953, experiments have been conducted by injecting natural gas into the blast furnace.

The basic idea behind natural gas injection is to replace a portion of the coke with carbon from natural gas, and to increase the reducing power of the bosh gases by hydrogen enrichment.

On November 23, 1959, a full scale test was conducted with natural gas being injected into all of the tuyères. The test was successful and natural gas has been injected continuously since that date. Three steps were taken when gas was put on the furnace.

1. Pounds of carbon charged into the furnace top were reduced by an amount equal to the pounds of carbon to be supplied with natural gas. The hydrogen content of the gas was not considered during this initial coke reduction. Coke reduction was made prior to the injection of gas. Time between coke reduction and gas injection was furnace retention time.

2. When gas was injected hot blast temperature was increased approximately 100 F for each gas injection equivalent to 1 per cent of the blast volume.

3. Coke input was further reduced in small increments; after each coke reduction hot blast temperature was increased.

Gas injection has reduced the coke rate, enabled the furnace to operate smoothly with higher hot blast temperature and has increased production.

With the reduction in the coke unit, the furnace has more iron bearing material in the shaft. These materials are in contact with stronger reducing gases for a longer period of time. They enter the bosh more nearly reduced, lowering hearth temperature requirements and contributing to a more efficient furnace.

"OXY-FUEL PROCESSES INCREASE STEEL-MAKING RATES"

by E. F. KURZINSKI, Manager, and R. D. JONES, Development Engineer, Applied Research and Development Div., Air Products, Inc., Allentown, Pa.

E. F. KURZINSKI

ROBERT D. JONES

Δ OXYGEN is the key reason for the present resurgence in thinking of the open hearth as the primary steel production furnace for the forseeable future. Present oxygen practices, coupled with basic refractories, have made possible increases in steel production rates of up to 40 per cent over prior rates without oxygen or basic bricks. A recent development, the oxy-fuel process, promises to double and even triple the steelmaking rate of open hearths. This accelerated pace of the open hearth will be made possible by the expanded use of oxygen for combustion and for oxidation of metalloids.

Oxygen-fuel practices will minimize the scrap meltdown and the refining periods. During scrap meltdown, oxygen is burned with gaseous fuels to provide a flame temperature approaching 5000 F compared to present end burners operating at about 3500 F. Following hot metal, oxygen is introduced at high flow rates to intensify decarbonization.

The oxygen-fuel mixture is generally introduced by water-cooled lances positioned in the open hearth roof using equipment similar to present oxygen roof lances. This same equipment is then used to introduce oxygen alone. Development work has also been conducted using water-cooled lances located in the furnace end wall. These end jets are designed for those shops having limited overhead clearance.

This paper is a progress report on the results obtained to date in the oxy-fuel process using both roof lances and end lances. This paper will also describe the oxy-fuel equipment used, the problems encountered to date, the aims of co-operative furnace programs presently underway and the future potential.

"SOLUTIONS TO BASIC L-D PLANT LAYOUT PROBLEMS"

by J. W. IRVIN, Senior Project Engineer, Kaiser Engineers, Div. of Henry J. Kaiser Co., Oakland, Calif.

J. W. IRVIN

Δ MANY L-D furnaces, with capacities between 35 and 300 ingot tons per heat, have been constructed or are being considered by steel producers to supply high quality steel at lower costs. While each of these plants presented many common engineering problems, solutions in each case were different. These problem areas included

production requirements, materials handling, plant location and capital and operating costs along with utilization of tie-in and with existing facilities.

This paper describes the approach and a solution for each problem. The author selects a hypothetical plant expansion with a nominal requirement of 1,500,000 additional tons per year and concludes that a two-furnace shop of 150-ton furnaces will meet the requirement. On the basis of present and future ingot requirements, a sound selection is made of the proper furnace size to produce the required tonnage most economically.

Methods are shown for the selection of proper scrap charging procedure on the basis of capital and operating costs, furnace cycle time and reliability of equipment. The factors affecting the selection of hot metal handling facilities, slag handling facilities, gas cleaning equipment and flux handling facilities are discussed. The investigation necessary to provide an optimum arrangement of teeming facilities is developed. The final result is the optimum layout which will meet production requirements within the restrictions imposed.

The author points out potential problem areas not specifically covered in the hypothetical example, such as development of lance storage and repair, and provisions for improved technology in automation and instrumentation. Finally, the author outlines a method of evaluating stand-by equipment such as a spare hot metal crane and stand-by reladling equipment. The paper concludes with the final general arrangement drawings which define the scope of work and must be supplemented by detail engineering.

"THE PRODUCTION AND USES OF ALUMINIZED STEEL"

by JOHN D. SPROWL, Research Engineer, Dept. of Metallurgical Research, Kaiser Aluminum & Chemical Corp., Spokane, Wash.

J. D. SPROWL

△ ALUMINUM coatings are applied to steel to provide corrosion and heat resistance. Methods of applying the coatings include hot-dipping, metal spraying, cladding, vacuum deposition, electro-plating and methods employing aluminum powders. These methods are described with emphasis on the hot-dip processes which are used commercially.

The characteristics of aluminized steel are discussed in terms of the properties of the aluminum layer and the aluminum-iron alloy layer which bonds the aluminum to the steel. The aluminum layer provides corrosion resistance and appearance, but these properties may be affected by the coating alloy composition. The formability of aluminized coatings increases as the thickness of the alloy layer decreases, which accounts for the excellent ductilities of clad and electroplated coatings. In hot-dip processes, however, the alloy layer thickness is controlled by coating alloy composition, the temperature of the coating bath and the time during which the steel contacts the molten aluminum.

Cost factors are briefly considered. Although material costs for aluminizing are low, capital and operating costs may be slightly higher than those for coating with other metals. Nevertheless, aluminized products are considered to be economically competitive.

Consideration of the potential markets and advances in technology indicate wider usage of aluminized steel.

"USE OF THE OPEN COIL PROCESS TO CHANGE COMPOSITION AND PRODUCE IMPROVED SHEET STEELS"

by JOHN A. BAUSCHER, Vice President-Research, Lee Wilson Engineering Co., Inc., Cleveland, Ohio

J. A. BAUSCHER

△ THE unique feature of the open coil annealing system is the provision of separation or air space between the individual wraps of cold-rolled coils of sheet and tin plate steels. Annealing atmosphere gas is passed through these separations between the wraps of the coil so as to heat and cool the entire coil very rapidly and very uniformly. In contrast, the tightly wound coils used in conventional batch annealing are heated and cooled very slowly because heat can only be transferred to and from the large mass of the coil through its relatively small exterior area.

It was found that excellent drawing-quality steel sheets could be produced with open-coil annealing cycles of only ten hours total time from the start of heating to the completion of cooling. To obtain the same steel properties by conventional batch annealing, annealing cycles as long as a week are required. Also, it was found that all the various tin plate tempers, including the continuously annealed T-U temper, could be produced with open-coil annealing cycles of only about eight hours duration.

Continuing research on open-coil annealing has now revealed that, in addition to conventional annealing, the process can be used to change the composition of steel. That certain gases will react at elevated temperatures with the impurity and alloying elements in steel has long been known, and considerable small-scale laboratory work has been done along this line. As long as 20 years ago, for example, M. Gensamer and J. R. Low were able to remove virtually all the carbon and nitrogen from small samples of sheet steel by annealing them in moist hydrogen. Commercial use of the known gas-metal reactions during annealing has been very limited because suitable large-scale equipment has not been available. In conventional batch annealing, the steel surfaces are not exposed to the annealing atmosphere so the reactions cannot occur. With only a few exceptions (notably the silicon-bearing electrical steels) in continuous annealing, the steel is not exposed to the annealing atmosphere long enough to permit the reactions to proceed beyond the very initial stages.

Neither of these limitations applies too pen-coil gas alloying and annealing. All the steel surface can be exposed to the annealing atmosphere for as short or

as long a time as is necessary to insure that the gas-metal reactions proceed to the desired end-point. Because of this, the potential uses of gas alloying by open-coil annealing are many, and a whole family of new steel products will undoubtedly result. Sufficient research has already been done to prove that a "direct-on" enameling steel can be produced by open-coil gas alloying. The open-coil annealed "direct-on" enameling steel offers economic advantages to both the steel producer and the enameler. The open-coil gas alloying system can also be used to produce a nonaging rimmed steel, which should be a less expensive substitute for the aluminum-killed steel presently used in many critical applications. Other research with open-coil gas alloying have indicated that the process can also be used: (1) to improve the magnetic properties and aging characteristics of the plain-carbon and the silicon steels used in motors and other electrical equipment; and (2) to make soft, easily rolled steels harder and stronger by increasing their carbon and/or nitrogen contents during annealing.

"THE APPLICATION OF NON-CONTACTING MEASUREMENT SYSTEM FOR COATING WEIGHTS ON CONTINUOUS GALVANIZING LINES"

by J. E. REIDER, Area Manager, Industrial Nucleonics Corp., Columbus, Ohio

J. E. REIDER

Δ RECENT developments in the automotive industry have indicated that the producers of galvanized sheet and strip may be in a position to greatly expand their present market. Reports of the intended usage of galvanized strip and sheet in the lower components of auto body parts may result in approximately 300 lb of galvanized steel being used per unit. This would require an additional 600 to 750,000 tons of galvanized sheet and strip annually. This is a completely new market and would add considerable emphasis to production. It represents approximately 18 per cent of total U. S. production of continuous hot dip galvanizing capacity.

Although no present specifications are available on the auto market galvanized product, it is understood that this production will have much tighter tolerances and will require tightly controlled differential coating. Apparently, it will not be possible to supply a galvanized strip with excessive zinc coatings in order to insure corrosion resistance and meet minimum weight standards. Excessive zinc may affect the manufacturers ability to obtain sound welds and his specifications will undoubtedly limit maximum coating permissible. This, coupled with the fact that minimum coating weights must be completely uniform to insure corrosion resistance, imposes very definite production difficulties on the supplier.

It will be difficult, if not impossible, for the galvanized stripper sheet producer to maintain the close tolerances which may be set by the automotive industry with spot or chemical test procedures. Some form of continuous, accurate, reliable and on-the-production-line coating weight measurement system will be required to meet the industry standards of the very near future. Noncontacting radiation reflection measuring systems provide the producers with a means for meeting these new tight industry tolerances. These systems will provide the basic tool for expanding the present market by approximately 18 per cent and at the same time can afford the producer significant economic returns on their investment.

The use of this type of equipment on production lines is not new but it is very timely. This paper will deal with three sections which should be of interest to galvanized strip and sheet producers:

1. Equipment.
2. Calibration, accuracy checks and reproducibility.
3. Results, both of an economic and quality nature.

The main emphasis of the paper will be upon the improved quality that can be obtained through the use of this equipment and the economic results that can be realized by the user. As an example, actual installations of this equipment have shown approximately a 5 per cent savings in zinc consumption, an approximate 50 per cent reduction in scrap and an increased throughput of about 0.5 per cent by time saving on specification changes and possible line speed increases due to continuous knowledge of the coating weight being applied. There are also the intangibles of increased product uniformity and use of the equipment as engineering trouble shooting and training tool. All of these advantages will add to a very significant economic return to the producer. Actual installations have shown an approximate $80,000 to 115,000 per year return to the user. This amounts to an approximate $11 to 15 per hr return from the equipment and is the basis for predicting an equipment write-off of much less than the generally accepted 12-month period.

Be Sure To Attend The Inspection Trip!

Kaiser Steel Corp.

Fontana, Calif.

Wednesday, March 1

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, March 27, 1961—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"The Automated Hot Strip Mill," by R. G. Beadle, Senior Application Engineer, System Development Section, and H. S. Maxwell, Application Engineer, Metal Rolling and Processing Engineering, Industrial Engineering Operation, General Electric Co., Schenectady, N. Y.

Redmont Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, March 14, 1961—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Computers in Utilities and Fuel Dispatching" by L. I. Dickinson, Fuel Engineer, Bethlehem Steel Co., Lackawanna, N. Y.

Sheraton Hotel, 715 Delaware Avenue, Buffalo, N. Y.

CANTON SECTION

Monday, March 20, 1961—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Steel Plant Maintenance Problems and Solutions,"

"Maintenance of Plant Heating and Lighting Systems," by W. M. Leavens, Plant Engineer, E. W. Bliss Co., Canton, Ohio

"Metallurgical Fundamentals of Mechanical Maintenance," by S. J. Thomas, Maintenance Metallurgist, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio

"Control of Acid Fumes," by R. R. Millar, Superintendent, Mechanical Dept., Republic Steel Corp., Massillon, Ohio

"Maintenance Advantages in Using Interlocked Armored Cable on Mill Cranes," by W. C. Bennett, Chief Engineer, Alliance Machine Co., Alliance, Ohio

"Maintenance of Mobile Equipment," by Frank C. Wier, President, Midstate Industrial Trucks, Inc., Massillon, Ohio

Mergus Restaurant, Canton, Ohio

CHICAGO SECTION

Tuesday, March 7, 1961—Dinner 6:15 P.M., Meeting 7:45 P.M.

"Modernize Mills or Replace Them?" by T. F. Plimpton, Assistant Vice President in Charge Research and Planning, Inland Steel Co., East Chicago, Ind.

Phil Smidt's Restaurant, 1205 Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, March 28, 1961—Inspection Trip 1:15 P.M., Dinner 6:30 P.M., Meeting 7:45 P.M.

Inspection Trip: Parma Research Center of Union Carbide Corp. Chartered buses will leave the Cleveland Engineering and Scientific Center at 1:15 P.M. (Plant tour 2:00 P.M.) and will return there for dinner and the meeting.

"Development and Use of Scale Layouts for Steel Plant Planning," by Harry J. Wiskofske, Method Engineering Leader, Industrial Engineering, Republic Steel Corp., Cleveland, Ohio

Dinner and Meeting, Cleveland Engineering & Scientific Center, 3100 Chester Avenue, Cleveland, Ohio

COLORADO SECTION

Tuesday, March 21, 1961—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Progress in Combustion," by E. F. Pearson, Engineer, Combustion Dept., The Colorado Fuel and Iron Corp., Pueblo, Colo.

Minnequa University Club, Pueblo, Colo.

DETROIT SECTION

Tuesday, March 14, 1961—Dinner 6:30 P.M., Meeting 8:00 P.M.

J&L Stainless & Strip Div. Night

"A Symposium on Refractory Materials" (Research, Development and Application), by C. A. Brashares, Vice President, Sales, Harbison-Walker Refractories Co., Pittsburgh, Pa.

Horace Rackham Educational Memorial Building Dinner and Meeting, Parlors E, F and G, Detroit, Mich.

LOS ANGELES SECTION

No March Meeting

PHILADELPHIA SECTION

Saturday, March 4, 1961—Dinner 6:00 P.M., Meeting 7:00 P.M.

"Cooling on a Carbon Hearth and Bosh," by L. W. Butz, Assistant Superintendent, Blast Furnaces, and L. P. Elly, Master Mechanic, Blast Furnaces, Bethlehem Steel Co., Bethlehem, Pa.

"A Combination Contour and Block Lathe for the Turning of Mill Rolls," by Ernest E. Davis, Superintendent of Hot Mills, and Albert H. Highley, Assistant Superintendent, Hot Rolling Mills and Roll Designer, The Carpenter Steel Co., Reading, Pa.

"Electronic Maintenance at Fairless Works," by F. E. Weinheimer, Foreman Electric Test and Communications, Central Shops Dept., Maintenance and Utilities Div., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, March 13, 1961—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Precision Raw Material Inventory by Photogrammetric—Nuclear Methods," by Robert A. Cummings, Jr., Robert A. Cummings, Jr. & Associates, Pittsburgh, Pa.

"Nuclear Methods for Moisture and Density Analysis," by Dr. O. K. Neville, Vice President, Nuclear Chicago Corp., Chicago, Ill.

University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday March 29, 1961—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Material Handling Problems—Panel Discussion," by Matt S. Wilson, Plant Engineer, Granite City Steel Co., Granite City, Ill.; N. Gail Weinrich, Assistant to Superintendent—Wire Mill, Laclede Steel Co., Alton, Ill.; Leland F. Kreid, Olin Mathieson Chemical Corp., East Alton, Ill.; E. C. Fields, Lewin Mathes Co., St. Louis, Mo.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

Tuesday, March 21, 1961—Social Hour 6:00 P.M. Dinner 7:00 P.M., Meeting 8:00 P.M.

Bethlehem Steel Co. Night

"Organizing to Get Our Share of the Materials Market," by J. D. Briggs, Manager, Commercial Research and Industrial Dev., Bethlehem Steel Co., South San Francisco, Calif.

Spenger's Fish Grotto, 1919 Fourth St. (near University Avenue), Berkeley, Calif.

UTAH SECTION

March 25 & 26 (Tentative)

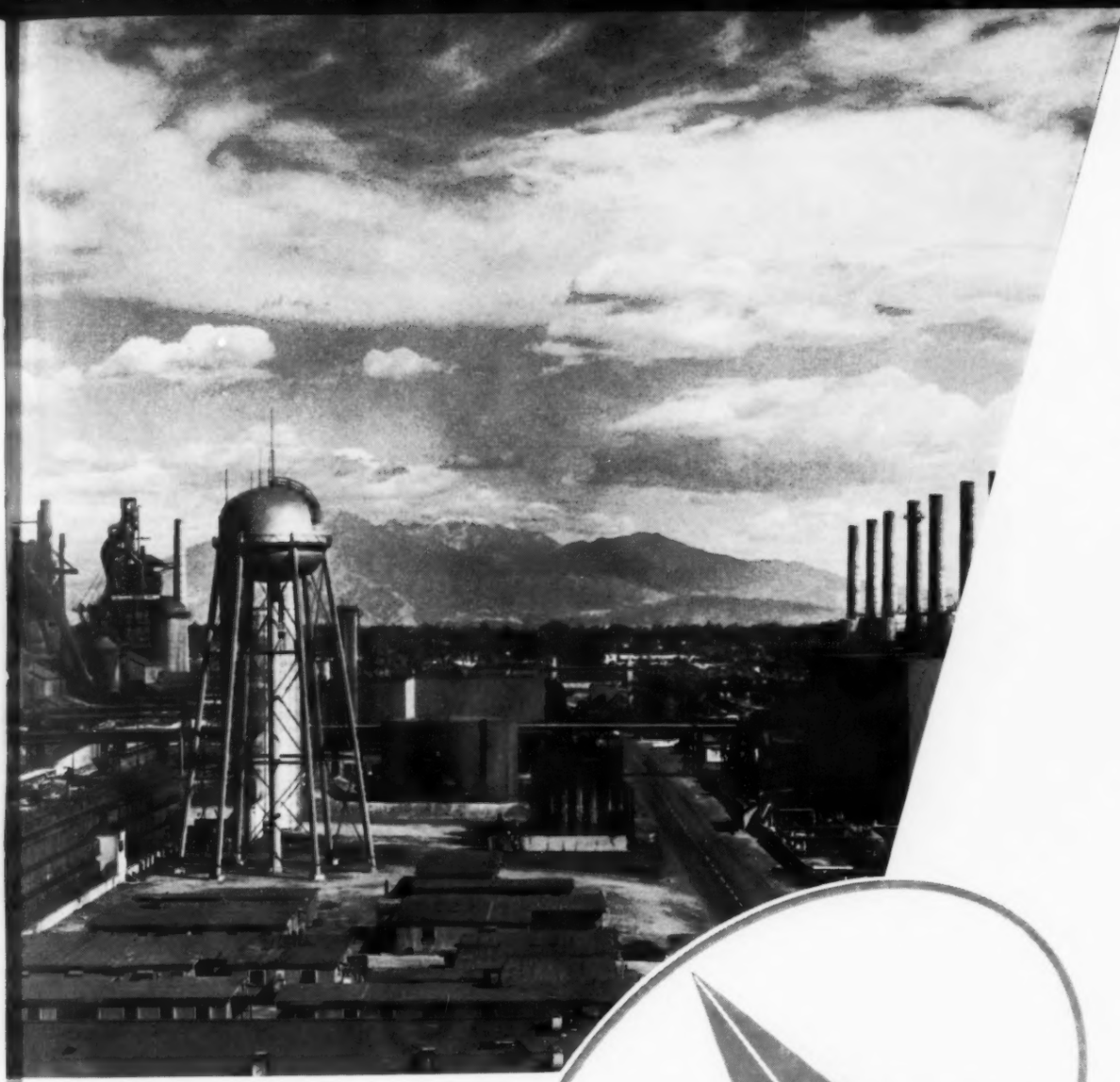
Field trip to Glen Canyon Dam Construction Site. (Details not available)

YOUNGSTOWN SECTION

Monday, March 27, 1961—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Rectifier Drives Applied to Rolling Mills," by M. B. Antrim, Manager, Engineering and Construction Div., Lukens Steel Co., Coatesville, Pa.

Mahoning Country Club, Girard, Ohio



KAISER STEEL

KAISER STEEL...

by T. J. Ess

ABOUT 18 years ago, shovels and bulldozers attacked a 1300-acre piece of farm land (later expanded to 1800 acres) in the San Bernardino valley about 45 miles east of Los Angeles, beginning construction of a steel plant. In spite of wartime shortages, a steel plant materialized here in less than three years. In spite of pessimistic predictions, the plant has expanded and diversified with an almost constant program of construction.

The original plant had an annual ingot capacity of 1,028,000 tons. Ten years later the capacity had risen to 1,536,000 tons—and today, seven years later, to 2,933,000 tons. The original plant produced principally plate, structurals and merchant bars. Today, the products and capacities are as follows:

	Tons per year
Heavy structurals	117,000
Sheared plate	511,200
Universal plate	16,100
Sheets	429,000
Coils for cold reduced black and tin plate	483,700
Skelp	537,500
Strip	2,700
Bars	55,800
Reinforcing bar	50,000
Forging blooms and billets	9,700
Total hot rolled product	2,212,700

Further processing of some of these hot rolled items provides the following:

	Tons per year
Cold rolled sheet and strip	36,000
Electrolytic tinplate	371,000
Hot dip tin and terne plate	70,000
Butt-weld pipe	120,000
Electric-weld pipe	292,000

Providing work for 9500 people, the Fontana plant is an important unit in the industrialization of the west. It provides steel for the various industries which have sprung up there.

FONTANA PLANT

J. L. ASHBY
President

C. F. BORDEN
Executive Vice President

C. L. EMERSON
Vice President-Sales

RAW MATERIALS

Ore for the blast furnaces comes from the company's Eagle Mountain mine, 163 miles from Fontana. Reserves, consisting of magnetite, hematite and some limonite, have been proved for more than 25 years of operation. Analyses are given in Table I. The ore is bench-mined by drilling and blasting, with five electric shovels loading the ore into 29 trucks of 22 to 64 tons capacity.

New crushing and screening facilities have been installed, including a 60-in. gyratory primary crusher which breaks up the ore to 7 in. x 0, a secondary crushing plant with two 7-ft standard cone crushers and four 7-ft short head cone crushers, and four 250,000-ton blending piles, all connected by a system of belt conveyors. The secondary crushers reduce ore to $\frac{3}{4}$ in. x 0 at rates up to 1500 tons per hr. Following the primary crusher are two 6 x 16-ft scalpers which remove ore over 3 in. This portion is put through the two standard cone crushers, where it is reduced to 3 in. or smaller. All of the 3 in. x 0 ore than passes through four 6 x 16-ft vibrating screens, where $\frac{3}{4}$ in. x 0 material is removed and the remainder put through the four short head cone crushers. Finally, four 6 x 16-ft vibrating screens size the recrushed ore to $\frac{3}{4}$ in. x 0. The crushing and screening equipment will turn out 1500 tons per hr of sized ore.

The sized ore is moved by conveyors and stackers to four new blending piles. The new blending piles serve to even out chemical and physical variations in the ore as mined.

Ore is reclaimed from the blending piles by a rotary plow-type reclaimer, then fed through a magnetic separation plant where the magnetite is separated out. The coarse nonmagnetic portion then goes to a heavy media separation plant where the ore is concentrated

TABLE I
Iron Ore Analyses, per cent

	Eagle Mountain for blast furnaces	Purchased (for steelmaking)
Fe	58.5	62.0
P	0.070	0.20
SiO_2	7.30	5.0
Al_2O_3	1.10	0.8
CaO	1.50	1.2
MgO	3.40	1.40
S	0.480	0.030
Mn	0.07	...

Iron ore for Fontana comes from Kaiser's extensive reserves at Eagle Mountain in the Southern California desert.

and the gangue removed. The fine nonmagnetic portion goes through a jig plant for beneficiation.

Concentrates are fed to two stock piles, one coarse and one fine. Ore is reclaimed by conveyors from these stock piles and loaded into special 100-ton cars, and taken over a 51-mile company-owned spur to the main line of the Southern Pacific Railroad which moves them to Fontana. Approximately 9525 tons of ore are required per day.

At the steel plant, cars are unloaded by rotary car dumper and the ore is handled by belt conveyors and traveling boom stackers on to six stockpiles 555 ft long x 55 ft wide. Ore is taken from these beds by a rake reclaimer and conveyed by belts to the blast furnace stock bins. This equipment handles 900 tons per hr.

Fine ore is taken to the stock bins of the sintering plant, mixed with flue dust, coke breeze and roll scale and sintered on two machines rated at 1500 tons per day each. These units are 72-in. wide x 102-ft long with 16 wind boxes and 144,000-cfm suction fans. Sintering capacity is rated at 1,095,000 tons per year, but production runs about 1,387,000 tons per year.

Coal for coking comes from four sources, as shown in Table II. Company-owned mines at Sunnyside, Utah, and Raton, New Mexico, produce high-volatile coals. At Sunnyside, coal is crushed to −8 in., the −4 in. portion screened out, washed and remixed with the 4 in. x 8 in. portion. This removes approximately 2 per cent of the ash and 0.2 per cent of the sulphur. Beneficiation facilities are being installed at Raton.

Low-volatile and medium-volatile coals, which are purchased from several independent mines, are not washed but only hand-picked and screened over a 2½-in. screen.

Total coal requirements run about 6600 tons per day.

Limestone comes from two sources: a company-owned quarry at Cushenberry in Lucerne Valley and a purchased supply for the open hearths from Las Vegas, Nevada.

Blast furnace stone is crushed at the quarry to 3½ in. x ½ in. It arrives at the plant by rail and is handled at 450 tons per hr by rotary car dumper and belt conveyors to the furnace bins or to storage. Its analysis averages somewhat as follows:

	Per cent
SiO_2	1.5
CaO	54.

Stone for the open hearth goes to a railroad high line and into stock bins.

Burned lime for the basic oxygen steel plant arrives by rail and is handled through track hopper and a 100-ton per hour belt conveyor system to two 650-ton elevated stock bins.

Daily consumption with full operation runs 2000

At the steel plant, ore is put into six stock piles from which it is reclaimed so as to average out variations in analyses.

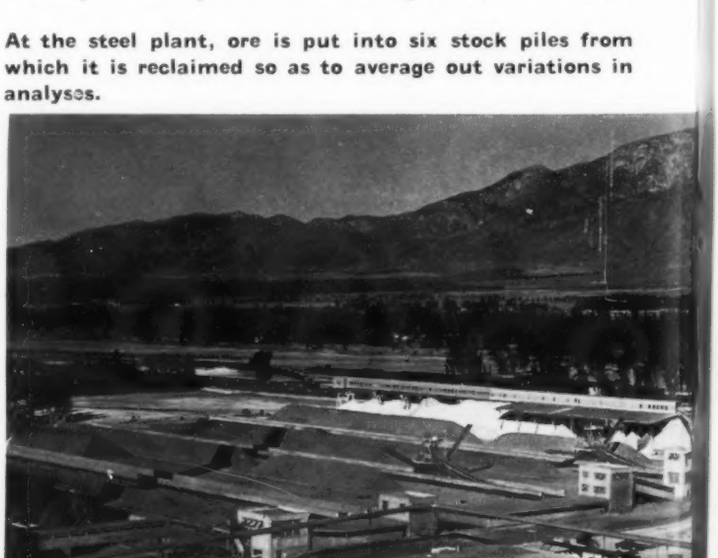


TABLE II
Coal Analyses (dry percentage)

	Company mines		Purchased	
	Sunnyside	Raton	Low volatile	Medium volatile
Moisture	3.0	3.0	3.0	3.0
Ash	7.0	10.0	9.0	6.0
Volatile matter	41.0	39.0	18.0	26.0
Fixed carbon	52.0	51.0	73.0	68.0
Sulphur	1.25	0.65	0.90	0.70

tons of limestone for the blast furnaces and sintering plant, 255 tons of stone for the open hearth and 175 tons of burned lime for the basic oxygen steel plant.

COKE PLANT

Arriving at Fontana, coal is unloaded by rotary car dumper and put into storage piles by belt conveyors and a traveling single-boom turntable stacker. Coal is normally stocked before use. It is spread, rolled and packed by bulldozer, to minimize variation in quality as received and to prevent atmospheric oxidation. Maximum storage time is 60 days. Mobile cranes with clam shell buckets are used to reclaim coal from storage. Stocking equipment operates at 840 tons per hr, reclaiming facilities at 600 tons per hr.

The coal is conveyed by belt to two breakers where the size is reduced to $1\frac{3}{4}$ in. From the breakers, the coal is sent to any one of four 750-ton mix bins. Two of these bins contain high-volatile coal, the other two contain low-volatile and medium-volatile coal. From the bottom of the bins the coal is measured by proportioning feeders in the correct proportions onto a belt conveyor leading to three vibrating screens equipped with $\frac{1}{4}$-in. decks.

Oversize material drops into three hammer mills with the fines ($-\frac{1}{4}$ in.) by-passing the mills. Size reduction as well as mixing is obtained in the hammer mills, which are adjusted to produce a product 65 to 70 per cent of which will pass through a $\frac{1}{8}$-in. mesh screen. Conveyors carry the blended and pulverized coal to three oven storage bins of 1800-ton capacity each.

The usual coal mix consists of 85 to 90 per cent high-volatile coals from Sunnyside and Raton, 5 to $7\frac{1}{2}$ per cent of the low-volatile coal and 5 to 15 per cent of the medium-volatile coal. The low-and-medium, volatile coals are used because very poor blast furnace operation results from the weak coke produced from 100 per cent high-volatile coal.

The coke ovens consist of seven batteries of 45 ovens each. Five are of the low differential under-jet type, two are of the low differential gun flue type. The oven dimensions are as follow: width at pusher side, 13 in., width at coke side, $15\frac{1}{2}$ in., length inside door linings, 40 ft-$5\frac{1}{2}$ in., height floor to roof, 13 ft. The ovens are normally heated with blast furnace gas. The capacity of each oven (576 cu ft) is 14.4 tons of coal at 50 lb per cu ft. Minimum coking time is 16.2 hours gross, or 465 ovens per day. Total carbonization capacity is 6600 tons of coal per day. Flue temperatures at this coking rate would be 2350 F.

All of the oven machinery is of conventional type. Pusher machines and door machines are all equipped for hydraulic latching of the oven doors. Oven doors on the two newest batteries are equipped with screw type latches. Larry cars are the conventional three-hopper type. The two newest larry cars are equipped with turntable feeders to provide better control of bulk density. The quenching equipment consists of three quench towers, three electric locomotives and three quenching cars.

The coke handling system consists of three wharfs feeding coke by conveyor belts to four storage bins, one at each of the blast furnaces. The capacity of these

B. N. DAGAN
Works Manager

E. F. DONATIC
General Superintendent

bins is 1200 tons each. The coke is screened over a $\frac{5}{8}$-in. screen just prior to loading into the furnace skips. The $\frac{5}{8}$-in. coke breeze is rescreened into $\frac{3}{8}$ in. $\times$ $\frac{5}{8}$ in. nut and $-\frac{3}{8}$ in. breeze. The $-\frac{3}{8}$ in. breeze is used at the sinter plant, while most of the nut coke is sold.

From the ovens, the gas flow is through five direct-type primary coolers, then through five turbo-exhausters of 19,800-cfm capacity each. Four of these units are normally operating and one is a standby.

Tar is removed from the gas stream after the exhausters by seven electrostatic precipitators. Ammonia removal from the gas stream is by one of two spray-type ammonia saturators utilizing a phosphoric acid mother liquor. Both saturators incorporate vacuum crystallizers for control of crystal size. The diammonium phosphate slurry is processed by either of two drying systems, centrifuges or a top-feed filter. From either system the wet salt is carried by belt conveyor to a rotary kiln-type dryer and thence to storage.

Ammonia removal from the gas liquor production is done by steam stripping in a bubble-cap type still, and the ammonia removed here is put back into the gas stream ahead of the primary coolers. Phenol is removed from the gas liquor by a dephenolizing tower and recovered as sodium phenolate. The sodium phenolate is processed in a springing plant utilizing waste oven gas as the springing medium.

After the ammonia saturators, the gas is again cooled by three final coolers and the light oils are removed in four spray-type scrubbers. A petroleum base wash oil is used as the absorbing agent.

Processing of the wash oil for the recovery of the light oil and the further refining of the light oil is accomplished in the benzol plant. The light oil is steam stripped from the wash oil and separated by rectification into two fractions: secondary light oil and intermediate light oil. The secondary light oil contains the benzol, toluol and xylol fractions. The intermediate light oil contains the heavier solvent fractions. All of these products are recovered by distillation and fractionation in varying degrees of purity to meet specifications.

After dehydrating to less than 2.0 per cent moisture, tar is pumped to a commercial tar products plant located adjacent to the steel plant.

Furnace coke yield averages 62 per cent and nut

Coke capacity of Fontana's 315 by-product ovens totals 1,502,000 tons per year.

coke and breeze, 5 per cent. By-product yields per ton of coal coked are about as follows:

Coke oven gas	11,300 cu ft
Tar	10.3 gal
Light oil	3 gal
Diammonium phosphate	21 lb
Phenol	0.05 gal
Pyridine	0.02 gal

Coke contains 10.5 per cent ash, 0.97 per cent sulphur, about 1.0 per cent volatile matter, and 88.5 per cent fixed carbon.

Since the ovens are heated principally with blast furnace gas, almost all of the coke gas is available for other uses. A small portion is sold to an outside consumer, while the rest is distributed at 3 to 5-psi pressure to soaking pits, reheating furnaces, sinter plant and boiler house. A 50,000-cu ft gas holder and a 100,000-cu ft holder are on this system. A stand-by gas supply is available from a mixing station where natural gas and air are mixed to a Btu value corresponding to that of the coke oven gas.

Coke capacity of the plant is set at 1,502,000 tons per year.

BLAST FURNACES

There are now four blast furnaces at Fontana. Three of these are essentially duplicates, and have been enlarged from their original lines. The fourth furnace is larger and was first put into operation in January, 1959. Some details of these furnaces are given in Table III. All hearths are cooled by cast iron staves. External jackets are used to cool the boshes, while copper cooling plates in the lining extend up into the stack for 10 to 40 ft above the mantle. Stocklines are protected by wearing plates, fabricated steel for No. 1, 2 and 3 furnaces, cast steel for No. 4 furnace. Hearth walls and bosh linings up to the mantles are of carbon block construction.

Gas, at about 400 F, leaves the furnace through four off-takes which combine on No. 1, 2 and 3 furnaces into two down-comers. No. 4 furnace has a single down-comer. No. 1, 2 and 3 furnaces each have a 29 x 38-ft dust catcher, a 20 x 56-ft tower washer, and two 22 ft-6 in. x 22 ft-11 in. electrostatic precipitator. No. 4 furnace has a 41 ft-6 in. x 56 ft-3 in. dust catcher, a 23 ft-6 in. x 70-ft tower washer and two 24 x 24-ft precipitators. No. 4 furnace is designed for operation with top pressures up to 15 psi.

Dust content in the gas ranges 0.05 to 0.08 grain per cu ft after the washer and 0.002 to 0.005 grain per cu ft after the precipitators. Flue dust averages about 33 lb per ton of iron.

About 35 per cent of the blast furnace gas is used in the stoves, with the surplus going to heat the coke ovens and to boiler fuel. A waterless type gas holder of 1,000,000-cu ft capacity provides storage to carry through brief delays.

Three 90-ft diam and one 100-ft diam settling basins receive water from the gas washers and precipitators. Sludge from these thickeners is disposed on a dump.

The furnaces are charged by conventional double skips with cars (200 cu ft on No. 1, 2 and 3 furnaces;

J. D. SAUSSAMAN
Asst. General Superintendent
Primary Production

R. C. MAC DONALD
Asst. General Superintendent
Finishing Mills

L. L. YOUNG
Asst. General Superintendent
Maintenance and Services

R. L. VAUGHN
Asst. General Superintendent
Technical Services

TABLE III
Blast Furnace Area

	No. 1	No. 2	No. 3	No. 4
Diameter of hearth, ft-in.	27-0	27-0	27-0	29-6
Diameter of bosh, ft-in.	30-6	30-6	30-6	32-6
Diameter of stockline, ft-in.	20-6½	20-6½	20-6½	22-0
Height, bottom to top ring, ft-in.	99-9	99-9	99-9	107-4
Height, iron notch to stockline, ft-in.	81-7 13/16	81-7 13/16	81-7 13/16	88-4
Height of crucible, ft-in.	12-6	12-6	12-6	12-10
Height of bosh, ft-in.	11-9	11-9	11-9	9-6
Height of straight section, ft-in.	0-9	0-9	0-9	10-0
Height of inwall section, ft-in.	61-7⅞	61-7⅞	61-7⅞	60-6
Height of stockline section, ft-in.	13-10⅞	13-10⅞	13-10⅞	14-6
Height, bottom to iron notch, ft-in.	2-3	2-3	2-3	2-4
Height, iron notch to cinder notch, ft-in.	4-8	4-8	4-8	4-8
Height, cinder notch to tuyeres, ft-in.	3-4	3-4	3-4	3-4
Working volume, tuyeres to stockline, cu ft	47,011	47,011	47,011	52,060
Bosh angle, deg-min-sec	82-52-31	82-52-31	82-52-31	81-1-39
Inwall slope, in. per ft	0.970	0.970	0.970	1.0413
No. of tuyeres	16	16	16	20
Tuyere diameter, in.	6	6	6	6
No. of columns	8	8	8	8
Lining thickness, crucible, in.	22½/27	22½/27	22½/27	22½/27
Lining thickness, bosh, in.	18	18	18	18
Lining thickness, stack, in.	40½	40½	40½	31½
Lining thickness, throat, in.	42	42	42	39½
Big bell diameter, ft-in.	14-5	14-5	14-5	16-0
Big bell angle, deg	50	50	50	53
Small bell diameter, ft-in.	6-0	6-0	6-0	7-0
No. of gas offtakes	4	4	4	4
Inside diameter of offtakes, ft-in.	5-4½	5-4½	5-4½	6-6
No. of campaigns	4	3	2	1
Date last blown in	1-2-60	2-12-60	11-25-59	1-7-59
No. of stoves	3	3	3	3
Stove diameter, ft	25-0	25-0	25-0	28-0
Stove height, ft-in.	114-6	100-0	99-5	124-4⅝
Checker openings, in.	(2) 4½ sq (1) 3½ sq	1 13/16 sq	1 13/16 diam	1 13/16 diam
Heating surface per stove, sq ft	(2) 141,000 (1) 124,823	185,403	183,170	320,038
Blast volume cfm, maximum	75,000	75,000	75,000	100,000
Blast temperature, F, average	1,416	...	1,312	1,505
Blast temperature, F, maximum	1,550	1,600	1,600	1,700
Lb of coke per net ton of iron	1,340	1,341	1,360	1,315
Daily iron production, avg, net tons	1,254	1,180	1,191	1,684

300 cu ft on No. 4 furnace) dumping into revolving distributor tops, all under automatic charging control. Large and small bells are actuated by pneumatic cylinders operating on the cold bast. The charging sequence is normally ore, stone, ore/coke, coke, coke, coke. Ore, stone and coke are all charged by weight.

Stock bins serving No. 1 furnace are of reinforced concrete, with capacity for 2475 tons of ore or sinter, 800 tons of stone and 1200 tons of coke. Bins for No. 2, 3, and 4 furnaces are of steel construction and provide storage for each furnace of 3120 to 5850 tons of ore or sinter, 600 tons of stone and 1200 tons of coke. All materials are brought to these bins by belt conveyors.

A typical burden for basic iron may be as follows:

	Lb per charge
Ore	20,000
Manganese ore	800
Sinter	22,000
Coke	16,800
Limestone	5,000

Blast for the four furnaces is provided by five turboblowers, one rated at 125,000 cfm, two at 100,000 cfm and two at 75,000 cfm. Electrostatic precipitators are installed in the intakes of the blowers to prevent cutting of the rotors by dust carried by prevailing winds.

Steam is added to the blast at times to maintain a moisture content of 5 to 15 grains per cu ft.

Each furnace is provided with three two-pass side combustion stoves. Gas is burned through proportioning pressure-type burners. Stoves are changed every 1½ hours. Blast temperatures are automatically controlled.

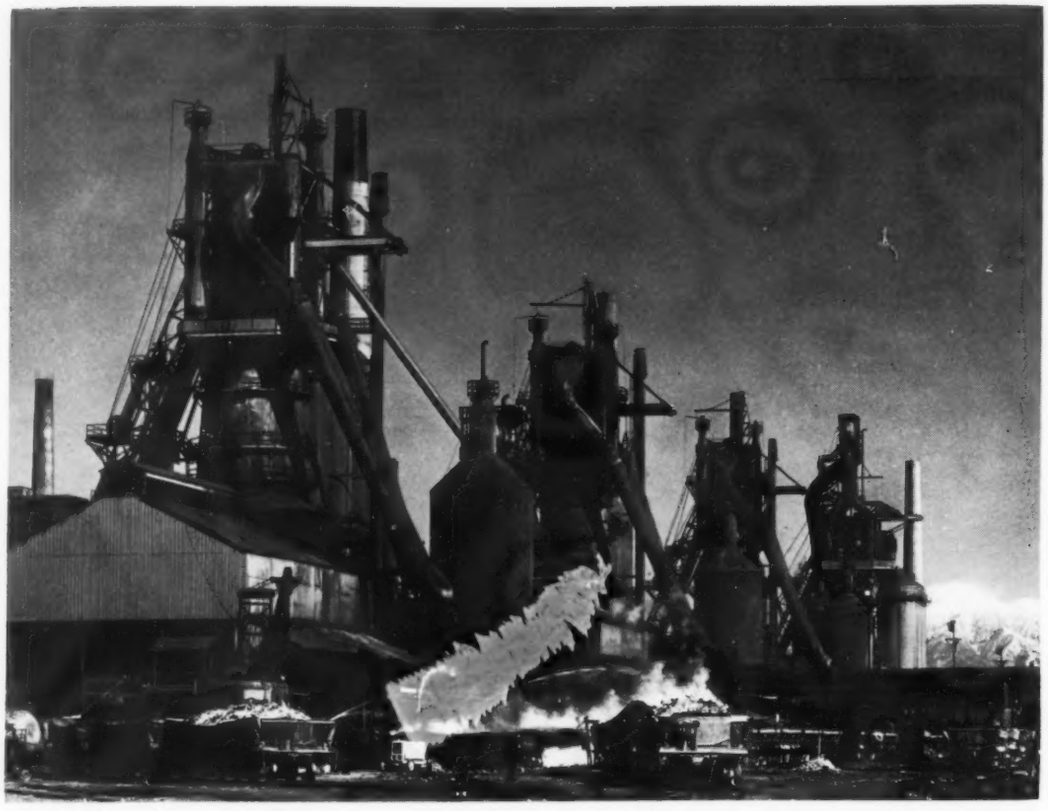
Iron production is preponderately of basic type with analyses averaging about as follows:

	Per cent
Silicon	1.11
Sulphur	0.033
Phosphorus	0.127
Manganese	0.44

The iron is used principally as hot metal in the open hearth and basic oxygen furnaces and in the foundry. Some iron is pigged for merchant trade.

The furnaces are cast every 4.8 hr, the iron flowing into 150-ton mixer type ladles, which are then moved to the steelmaking departments, foundry, or to a double-strand pig machine. This machine, 168 ft long, can cast 100 tons per hr into 50-lb pigs.

Daily iron production and coke consumption are given in Table III. Combined rated capacity of all furnaces totals 2,040,650 tons of iron per year. From 3000 to 3300 lb of ore and sinter are used per net ton of iron. Limestone consumption runs 400 to 600 lb per ton of iron. Slag ranging 900 to 1200 lb per ton of



Kaiser's four blast furnaces, the only ones on the West Coast, provide an annual capacity for 2,040,650 tons of iron.

iron, flows into dry pits adjacent to the furnaces, from which it is dug out by power-shovel and loaded into railroad dump cars for disposal on a slag dump. Slag analyses average somewhat as follows:

	Per cent
SiO_2	34.75
Al_2O_3	9.36
CaO	38.31
MgO	15.39
S	2.14
Fe	0.28
Mn	0.20

OPEN HEARTH

The plant has nine open hearth furnaces. Of these the original six furnaces are rated at 185 tons. Three furnaces added between 1948 and 1953 are rated at 200 tons. Principal dimensions of the furnaces are given in Table IV.

All of the furnace bottoms are formed of 2 in. of insulating concrete, 9 in. of first quality firebrick, 9 in. of burned chrome brick, and 16 in. of basic ramming mix, topped by a burned dolomite dressing. Backwalls are of sloping construction. Roofs are of sprung arch design, 18 in. thick with 24-in. ribs every fourth course. Four furnaces have experimental basic roofs, the rest, silica roofs. Front walls, back walls and port ends are of basic brick.

Furnace throats are only slightly constricted. Two uptakes on each end of the furnace lead to single slag pockets and a single regenerator chamber on each end. Checkerwork is laid up in basket-weave design, using 9 in. x 4½ in. x 3-in. brick to form 9-in. square flues.

A flue 5 ft-6 in. x 6 ft-6 in. leads from each regenerator to a stack flue which connects to a reinforced concrete stack 175 ft high for each furnace.

The furnaces are fired entirely with bunker C fuel oil, which is received in trucks or tank cars and unloaded by reciprocating steam pump into two storage tanks of 1,200,000 and 612,000-gal capacity, respectively. Oil in these tanks is maintained at a temperature of about 150 F. Line heaters in the pump room raise the temperature to 180 F, while individual heaters at each furnace are automatically controlled to give final oil temperatures of 200 to 220 F. Two 105-gpm rotary screw pumps move oil through the recirculating system.

Air is supplied to each furnace by a forced draft fan rated at 18,000 cfm, 4-in. water column. Furnace pressure is automatically controlled at about plus 0.07

TABLE IV
Open Hearth Furnace Dimensions

No. of furnaces	6	3
Nominal capacity, tons per heat	185	200
Over-all length, ft-in.	79-0	81-9
Over-all width, ft-in.	23-11	23-0
Hearth length, ft-in.	49-3¾	53-9
Hearth width, ft-in.	17-7½	17-3
Hearth area, sq ft	850	927
Bath, depth, in.	37	38
Roof span, ft-in.	21-9⅝	20-10½
Roof spring, ft-in.	3-5	3-7
Height, foreplate to skewback, front, ft-in.	4-10	4-10
Height, foreplate to skewback, back, ft-in.	4-10	4-10
Roof length between knuckles, ft-in.	48-0	50-7½
Uptakes, ft-in.	6-6 × 5-2	6-6 × 5-2
Uptake area, sq ft, each end	67.16	67.16
Slag pocket length, ft-in.	16-11	16-11
Slag pocket width, ft-in.	14-5½	15-10½
Regenerator length, ft-in.	30-0	30-0
Regenerator width, ft-in.	18-0	18-0
Checkerwork height, ft-in.	9-9	15-0
Checkerwork volume, cu ft, each end	5,150	8,030

in., water column. Recording and indicating instruments are provided for furnace pressure, air flow, oil temperature and oil flow. Indicating pressure gages are applied to oil and steam lines. Checker flue temperatures are recorded.

Oil is fed to the furnaces at a maximum rate of 600 gal per hr with basic roofs, 500 gal per hr with silica roofs. Oxygen to the extent of about 400 cu ft per ton of steel is used through the oil burners for flame enrichment. One furnace has been equipped with roof jets for evaluation purposes.

All of the furnaces are equipped with 13,000-sq ft waste heat boilers of fire tube design. They generate steam at 175 psi pressure, 450 F, and average 22,000 lb of steam per hr each.

To avoid air pollution, all open hearth furnaces are provided with dry-type electrostatic precipitators. The complete installation was made only after four years of test work on one furnace. The precipitators operate with efficiencies of 92 to 95 per cent.

Furnace charges consist of about 35 per cent scrap, 65 per cent hot metal. Iron comes to the open hearth in 150-ton mixer type ladles and is poured into 90-ton ladles which may be taken directly to a furnace or emptied into either of two 800-ton mixers, one at each end of the shop.

For deoxidizing, aluminum, silicon and manganese are used separately or in combination, as may be required by the type of steel being produced. Miscellaneous material consumption runs about as follows:

	Lb per ton of steel
Fluxes	120
Iron ore	155
Ferro alloys	21
Deoxidizers	1

The furnaces turn out heats of 205 and 225 tons, respectively, for the two furnace sizes. Heat time averages approximately ten hours, tap-to-tap. Fuel consumption averages about 2,800,000 Btu per ton of steel produced. Open hearth capacity is reported as 1,493,000 tons per year.

Most of the steel produced is plain carbon, but a little of low alloy grades is also made. It is poured into a variety of ingot molds: big-end-down from 25 to 70 in. wide x 23 to 30 in. thick x 80 to 86 in. long; bottle top from 38 to 56 in. wide x 25 to 30 in. thick x 80 in. long; and big-end-up from 25 to 70 in. wide x 23 to 31 in. thick x 62 to 82 in. long. Before teeming, ingot molds are dipped in an emulsion of graphite in water.

The furnaces are designed for front flushing, with slag flowing out the end door into an armored aisle between the slag pocket and the foundation pier. From here, it is loaded into side dump cars by a front-end loader. Tapping slag is transported to a cinder dump where it is crushed, loaded into dump cars and taken either to the blast furnace or to the slag dump, where an outside contractor processes it to recover metallics.

Open hearth facilities are principally housed in six parallel building bays as shown in Table V. The stripper building and skullcracker are conveniently located nearby. Open hearth buildings are of flat roof, high-and-low bay design in 25-ft bays, one low bay alternating with three high bays.

A lean-to is used principally for storage of alloys and miscellaneous materials. Part of the stockyard is roofed so that most materials except scrap are under cover. Elevated tracks in the stockyard permit the loading of scrap, limestone, ore, etc., directly into the charging boxes of a drag of buggies, which may then be shifted over crossovers into the charging bay.

Nine open hearth furnaces of 185 and 200 ton capacities turn out heats in about ten hours. Furnace charges average 35 per cent scrap, 65 per cent hot metal.

TABLE V
Open Hearth Buildings and Cranes

Building	Length, ft	Width, ft	Cranes	
			No.	Capacity, tons
Stockyard No. 1	750	85	1	10
			1	10/10*
Stockyard No. 2	825	100	2	10
			1	10/10*
Storage bay	1175	45	..	...
Charging bay	1475	72 6	3	125/30
			3	10**
Pouring bay	1325	74	3	250/50/15
Ingot run	1325	33	..	...
Mold preparation	700	80	1	15
Mold storage	550	80	1	25
Stripper building	300	65	2	200
Skull cracker and cinder yard	574	80	1	60/25
			1	40/15
			1	15

* Double trolley.
** Floor chargers.

BASIC OXYGEN STEEL PLANT

A recent addition to the Fontana plant is a 1,440,000-ton-per-year basic oxygen steel shop, the third installation using this process in the United States. The shop is based on three 110-ton oxygen steel furnaces placed on 75-ft centers. These vessels are 25 ft-5 in. high and 17 ft-9 in. in diameter outside, in shape much like bessemer converters but with a solid bottom. The mouth at the top is 7 ft in diameter. They are lined with burned periclase, 19 in. thick on the bottom, $4\frac{1}{2}$ in. on the walls, topped by a working lining of tar-bonded dolomite 18 in. thick over the bottom and $22\frac{1}{2}$ in. on the walls. The permanent lining is laid up in rings, the working bottom in soldier course and the working walls in spiral. Life of the working linings average about 225 heats.

The vessels are carried by trunnions which rest in bearings supported on cast steel pedestals. Each vessel is tilted by two 135-hp d-c motors.

Hot metal comes from the blast furnaces in 150-ton mixer cars, from which it is poured into 90-ton ladles. Two 250-ton scales weigh the hot metal. The ladle is then emptied into the oxygen furnace. Iron averages 1.21 per cent silicon, 0.029 per cent sulphur, 0.127 per cent phosphorus and 0.78 per cent manganese.

Scrap is unloaded by cranes either into storage or into charging chutes. The chutes, full of scrap, are moved by crane to a scale, then to the furnace. Chutes are emptied into the vessel by a crane.

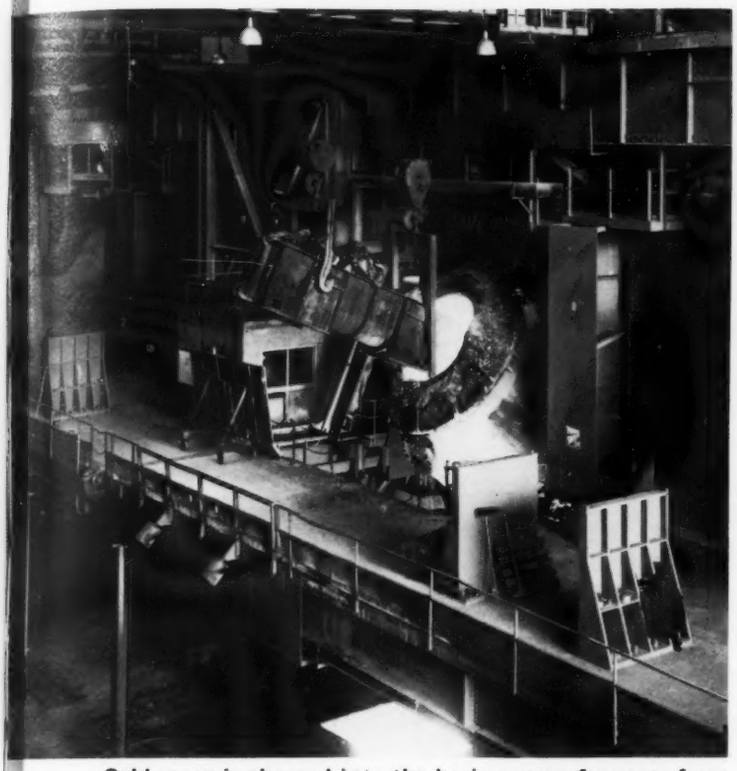
Miscellaneous materials are unloaded from hopper cars and moved by conveyor belts into nine outside storage bins, then moved by belt conveyor to storage hoppers at the top of the building. A control system, operated from the furnace pulpit, allows the operator to measure out specified amounts of burnt lime, fluorspar, roll scale, etc., which are then carried by belt conveyor to a holding hopper. These materials are then put into the furnace through a chute projecting though the hood as required during the blow.

After the hot metal and scrap are charged, the furnace is put into the upright position and a water-cooled lance, 46 ft long x 6 in. in diameter, with a 2.05-in. diameter nozzle is lowered to a predetermined position above the surface of the bath. Oxygen is turned on at 125 to 130-psi pressure, with a flow of about 7000 cfm.

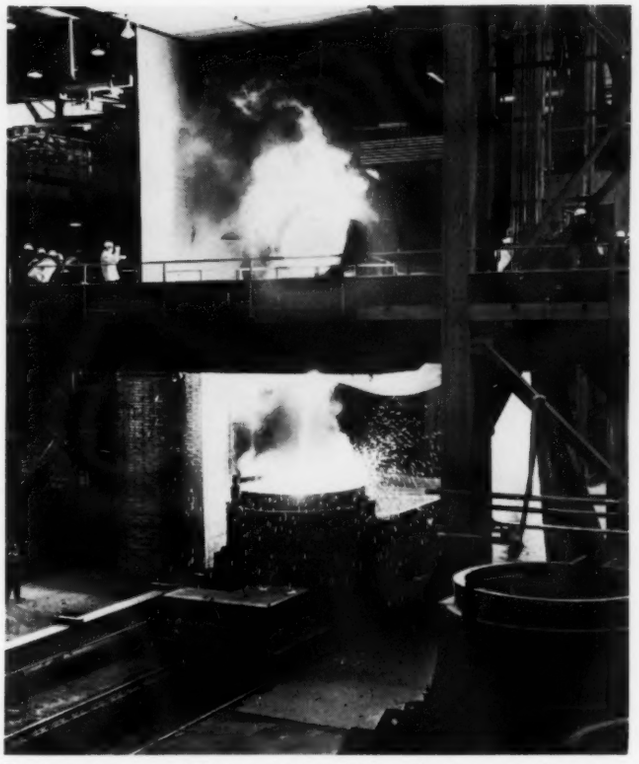
Progress of the oxidation process is judged by observation, instruments and experience. On steels of 0.12 per cent and less carbon, the end point is determined visually. For higher carbons, rapid analysis equipment is used. Oxygen flow and time are important guides.

When the blow is finished, the lance is withdrawn and the vessel is turned to a horizontal position to permit pouring off the slag into a pot resting on a self-propelled car beneath the furnace.

To the right of the basic oxygen steelmaking plant are the electrostatic precipitators which clean the gases resulting from the blows.



Cold scrap is charged into the basic oxygen furnaces from charging chutes handled by overhead crane.



Basic oxygen steel is tapped by tilting the furnace forward, the steel flowing into a 115-ton ladle riding on a car below.

The vessel is then turned down in the opposite direction to pour the steel through a tapping hole in the side into a 115-ton ladle, also on a self-propelled car beneath the furnace. Ladle additions, introduced through a chute fed by a payloader, might include manganese, ferro-silicon, ferro-phosphorus, ferro-vanadium, calcium cynamide, aluminum, etc., depending on the grade of steel being made.

While the blow is in progress, the nose of the vessel is immediately under a water-cooled hood 11 ft-6 in. in diameter x 46 ft high. Water is also sprayed into the hot gases, which then flow through a 12-ft main to a precipitator building nearby. The dry electrostatic precipitator is made in three sections (two operating, one standby). In 24 hours, the precipitators collect about 60 tons of dust, which is sent to the mill scale preparation plant.

A typical charge might consist of 70 per cent of hot iron and 30 per cent of steel scrap, roll scale and other miscellaneous materials. Time of actual blowing averages about 25 minutes. Heat time, tap-to-tap is about one hour. Oxygen consumption averages 1880 cu ft per ton of steel. Oxygen of 99.5 per cent purity is purchased from a commercial plant located nearby.

Flux consumption per ton of steel averages 148 lb of burnt lime, 33 lb of limestone, and 22.9 lb of fluorspar. About 28 lb of mill scale is used per ton of steel.

Heats average about 110 tons each.

The oxygen steel plant produces rimmed and capped steels up to 0.20 per cent carbon, and semi-killed steels up to 0.90 per cent carbon.

Molds are principally big-ends-down, 25 to 70 in. wide, 23 to 30 in. thick and 80 to 86 in. long. Bottle-top molds run 38 to 56 in. wide, 25 to 30 in. thick and 80 in. long.

The basic oxygen steel plant is 1300 ft long overall, and 127½ ft high at the highest point. The charging aisle is 74 ft wide, the furnace section 41 ft wide, and the pouring aisle, 74 ft wide. Two 135-ton hot metal cranes serve the charging aisle; two 135-ton ladle cranes are in the pouring aisle. A 450-ton stripper crane is provided.

BLOOMING AND SLABBING MILLS

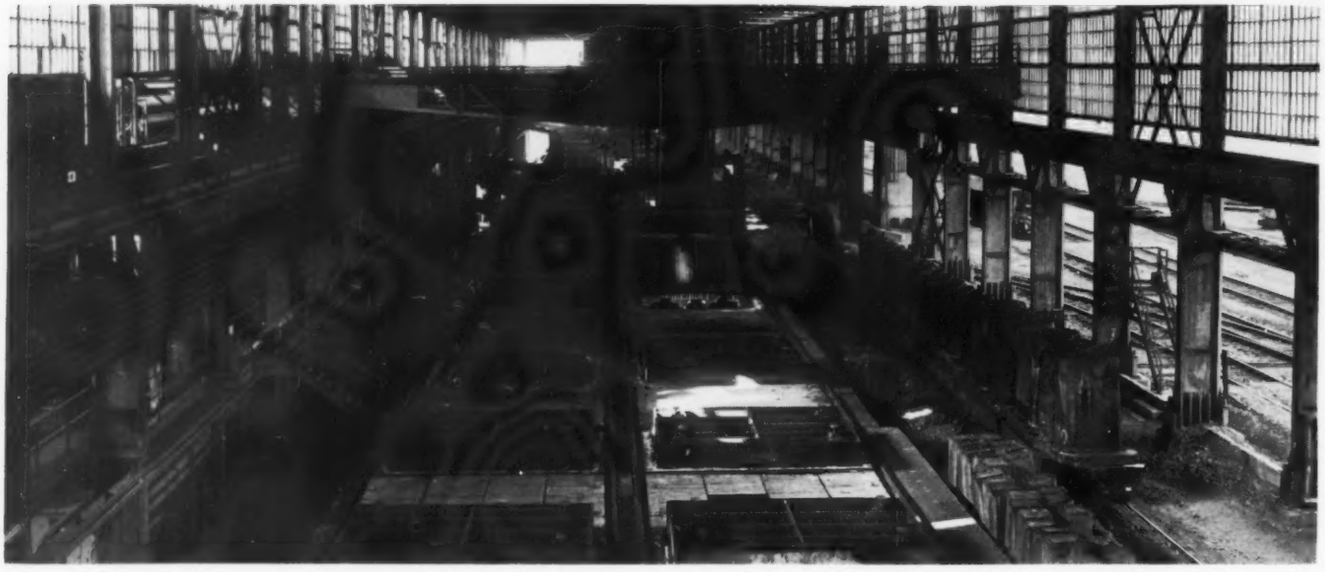
Primary mills at Fontana consist of a 46-in. blooming mill and a 46-in. universal slabbing mill. Ingots to be broken down on these mills usually come from the stripper and are charged into the soaking pits. Twenty blocks of two pits each are arranged in a straight line running across the two mill lines. Twenty-two pits measure 18 ft long x 13 ft-6 in. wide x 9 ft-9 in. deep. The remainder are 20 ft long x 13 ft-6 in. wide x 10 ft-6 in. deep. This provides a total useful hearth area of 8200 sq ft.

All pits are fired with coke oven gas or fuel oil through a central burner in the bottom. They have refractory tile recuperators which preheat combustion air to about 1500 F. Each pit is equipped with a forced draft fan and automatic controls on temperature, fuel-air ratio and furnace pressure. Ingots are normally charged to the pits at about 1500 F. Fuel consumption averages 500,000 Btu per ton of ingots.

There are also six preheaters, similar to the pits in design, which are used to heat cold ingots up to 1800 F before finishing the heating in the pits.

The pits are served by four 20/15-ton pit cranes.

For the blooming mill, the heated ingot is placed in a buggy running along the line of pits and carried to a lay down table, from which they are transferred to another buggy running at right angles to the first buggy and in line with the blooming mill table, which is some 340



Forty soaking pits, arranged in a double line, serve the blooming and slabbing mills. The pits are fired with coke oven gas or fuel oil.

ft from the soaking pits. This space was left for future installation of a larger mill.

The existing mill is a modification of the original 36-in. unit which was intended to serve ultimately as the rougher for the structural mill. As now constituted, the mill is a 46-in., two-high, high-lift reversing unit, driven by a 5000-hp, 50/120-rpm, 700-volt, single armature motor through pinions of 46-in. pitch diameter, 50-in. face. This motor, which can develop a maximum torque of 1,500,000 lb-ft, receives power from a motor-generator set consisting of two 2500-kw, 700-volt d-c generators, a 14-ft diameter, 77,000-lb flywheel, and a 4500-hp, 509-rpm, 6600-volt wound rotor induction motor.

The cast steel housings of the mill are of closed top design, with posts 26 x 24 in. Rolls are 38-in. maximum diameter with a body length of 82 in., and operate in composition bearings. The top roll is hydraulically balanced. A maximum roll opening of 58 in. is available. Mill screws, of 14-in. diam and 2¼-in. pitch, are driven by two 200-hp mill type motors under adjustable voltage control to give a maximum lifting speed of 40 fpm.

Side guards and lifting fingers on each side of the mill are driven by two 100-hp motors, and a 75-hp motor. Front and back mill tables, each 42 ft-6 in. long, are also controlled through adjustable voltage.

Mill scale is flushed into a scale pit from which it is removed by grab bucket.

About 138 ft beyond the mill is a 1200-ton hydraulic up-cut shear, capable of cutting sections up to 500 sq in. Crops are transferred by chain conveyor to crop boxes in a pit nearby.

Immediately following the shear is a 20-ft hot bed transfer to the left of the mill line, over which slabs and blooms are moved to pilers. To the right is a 30-ft transfer leading to other pilers.

This mill can produce blooms from 5 in. square to 8 x 17-in.; blanks for beams and channels up to 20 in., wide flange beams up to 10 in., and H-beams up to 8 in.; and slabs up to 48 in. wide, 2½ to 10 in. thick and 60 to 216 in. long. The mill averages 150 tons per hr, and has rolled 125,000 tons in one month. It is nominally rated at 1,123,000 tons per year. The blooming mill seldom rolls slabs since the installation of the universal slabbing mill. It now averages about 150 tons per hr on a product mix principally of blooms and beam blanks.

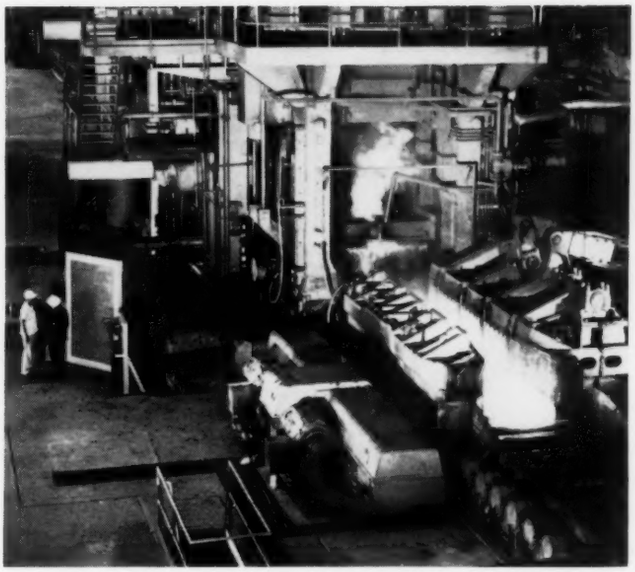
Soaking pits are completely equipped with automatic combustion controls. Control panels are located in houses along the operating floor.

The new unit is a 46 x 90-in. universal slabbing mill. It is a two-high, reversing unit with 38 x 80-in. vertical rolls centered 9 ft-2 in. beyond the horizontal rolls but in the same housing. Horizontal rolls operate in fabric bearings, vertical rolls in roller bearings. The top roll, which is hydraulically balanced, is moved up and down by mill screws 18 in. in diameter x 2½ in. pitch, driven by two 150-hp mill type motors under adjustable voltage control. Lifting speed ranges up to 600 in. per min and a maximum lift of 78 in. is available. Vertical rolls are adjustable for openings of 18 to 90 in. through the action of two 150-hp motors.

Horizontal rolls are driven through 22-in. universal mill spindles by two 5000-hp, 40/80-rpm, 700-volt d-c motors arranged in twin drive. Vertical rolls are driven by a 4000-hp, 60/150-rpm, 700-volt d-c motor.

Direct-current power for the main drive motors

The 46-in. blooming mill usually rolls ingots into blooms or structural blanks at rates averaging 150 tons per hour.



The new universal 46 in. x 90 in. slabbing mill supplies slabs for the plate mill and hot strip mill. It produces at an average rate of 375 tons per hour.

comes from a motor-generator set composed of four 2500-kw, 700-volt d-c generators and two 1750-hp, 700-volt d-c generators, all driven at 514 rpm by a 9000-hp, 6600-volt wound-rotor motor.

On both sides of the mill are movable sideguards, operated through racks and pinions by two 150-hp d-c motors, with manipulator fingers actuated by a 150-hp d-c motor.

A pair of feed rollers, individually driven by 44/88-hp, 82/184-rpm, 240/470-volt d-c motors, are placed ahead of the horizontal rolls, between horizontal and vertical rolls, and following the vertical rolls.

Front and back mill tables are each 26 ft-4 in. long, composed of 12 rollers of 20 in. diam x 90 in. body length. Each table is driven by two 150-hp mill motors under adjustable voltage control.

The mill receives ingots ranging from 26 x 34 in. (about 6 tons) to 23 x 78 in. (about 17 tons). It produces slabs running 20 to 72 in. in width, 4 to 12 in. in thickness. Maximum rolling speed is 960 fpm.

The slabbing mill is nominally rated at 2,808,000 tons per year, but rolls at an average rate of 375 tons per hr.

Following the mill at a distance of about 290 ft is a down-cut shear, driven by two 375-hp motors. It is capable of cutting sections up to 600 sq in. at 1700 F. Crop ends are pushed into a pit and carried by conveyor to a crop pit in the service yard. The single-screw shear gage handles lengths of 6 to 22 ft.

Leaving the shear, slabs are pushed on to a transfer which carries them to a parallel table line serving two slab pushers and magazine pilers in the slab yard.

At present, slabs are hand scarfed in this yard, although space has been left between the slabbing mill and its shear for the future installation of a scarfing machine.

Adjustable voltage control has been applied to the mill tables, feed rolls, screwdown, edger adjustment, manipulators, mill run-out and shear approach tables and slab shear. Power for these auxiliaries comes from three 8-unit motor-generator sets, each driven by an 1100-hp synchronous motor.

PLATE MILL

Plate was a major product of the original Fontana plant as it was built in 1943. Over the years, the original mill has been modified and rebuilt several times, and at one time was used as a rougher for a hot strip finishing train. After completion of a separate hot strip mill, the plate mill was rebuilt to its present form.

At present, the plate mill works on slabs from the universal slabbing mill, 20 to 64 in. wide, 4 to 10 in. thick and 66 to 216 in. long. It produces sheared plate 36 to 126 in. wide, $^3/_{16}$ to 4 in. thick, and 96 to 720 in. long.

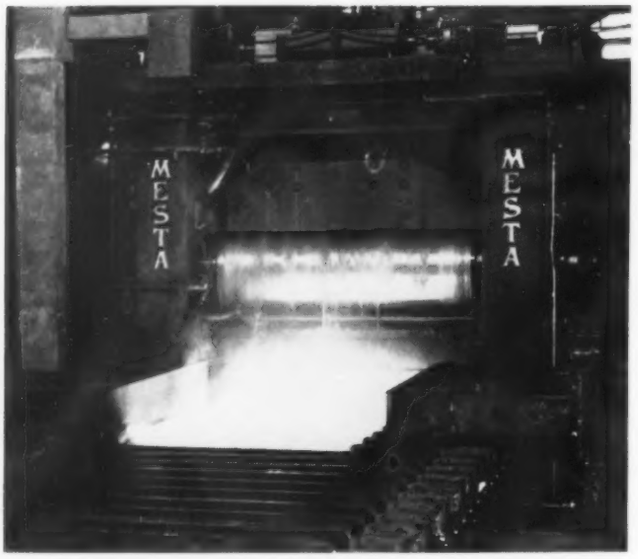
There are three recuperative slab heating furnaces, one 20 ft x 79 ft-6 in., one 23 ft x 79 ft-6 in., and one 23 ft x 100 ft. They are of three-zone construction, fired with coke oven gas or fuel oil under automatic combustion control.

Slabs are placed by cranes on magazine depilers, from which one slab at a time is pushed onto the furnace charging tables. A double ram type pusher on each furnace moves the slabs into and through the furnace.

Through the action of the furnace pushers, heated slabs are discharged on to the furnace discharge table, which carries them to the first mill stand, a 44 x 30-in. vertical edger, driven by a 1500-hp, 80/240-rpm, 550-volt d-c motor. The vertical rolls run in roller bearings and are adjustable through two 50-hp motors to give roll opening of 15 to 110 in.

The roughing stand is a 45 x 110 in. two-high reversing unit, located about 28 ft beyond the edger. The rolls operate in oil-film bearings and are driven through spindles 22 in. in diameter x 28 ft long by two 3500-hp, 30/75-rpm, 750-volt d-c motors to give a rolling speed of 346 to 865 fpm. The rolls may be adjusted to give opening up to 28 in. by two 16-in. diam, 1-in. pitch screws driven by two 100-hp motors.

The finishing stand, placed about 153 ft beyond the two-high stand, is four-high, with work rolls 38 x 148 in. and backup rolls 59 x 144 in., driven by a 7000-hp, 40/80-rpm, 750-volt d-c motor. This motor works



The 148-in. plate finishing stand is a four-high, reversing unit, driven by a 7000-hp motor. The plate mill rolls at an average rate of 95 tons per hour.

through pinions of 44-in. pitch diameter, 66-in. face and 20-in. diam spindles. Work rolls run in roller bearings, backup rolls in oil-film bearings. Roll openings up to 15 in. are available through action of 18 in. diameter, 1-in. pitch screws driven by two 150/300-hp motors.

The vertical edger and two-high stand drive motors receive power from a motor-generator set consisting of two 3000-kw and one 1250-kw, d-c generators of 750 volts, driven by a 6000-hp, 360-rpm, 6600-volt a-c motor. The four-high drive is served by two 3000-kw, 750-volt d-c generators driven by a duplicate 6000-hp motor.

Between the edger and two-high stand and between the two-high and four-high stands are turn-around tables, with rollers alternately tapered in opposite directions and a separate drive for each set of alternate rolls. This permits the slabs to be turned for cross-rolling to obtain widths greater than the maximum slab width.

To insure good product surface, descaling sprays are placed above and below the pass line on the entry side of the two-high stand and the four-high stand. Sprays on the two-high stand use about 600-gpm of water at 1100-psi pressure. The four-high sprays use about 1360 gpm.

Leaving the four-high stand, plate proceeds over the runout table to a cooling transfer about 70 ft long. Immediately preceding the transfer is a light roller leveler capable of handling material $\frac{3}{16}$ to $\frac{3}{4}$ in. thick up to 139 in. wide. This leveler may be moved out of the mill line when not in use.

The transfer leads to a parallel table line which contains a 156-in. end shear for plates up to 1 in. thick, and a rotary side trimmer. A second transfer connects this table to another parallel table which contains a 160-in. end shear for plate up to $1\frac{1}{2}$ in. thick and a heavy duty leveler capable of handling material up to 3 in. thick. Plate is finally rolled off to pilers or discharged on to a caster bed.

The plate mill is rated at 711,000 tons per year. It produces at an average rate of 95 tons per hr.

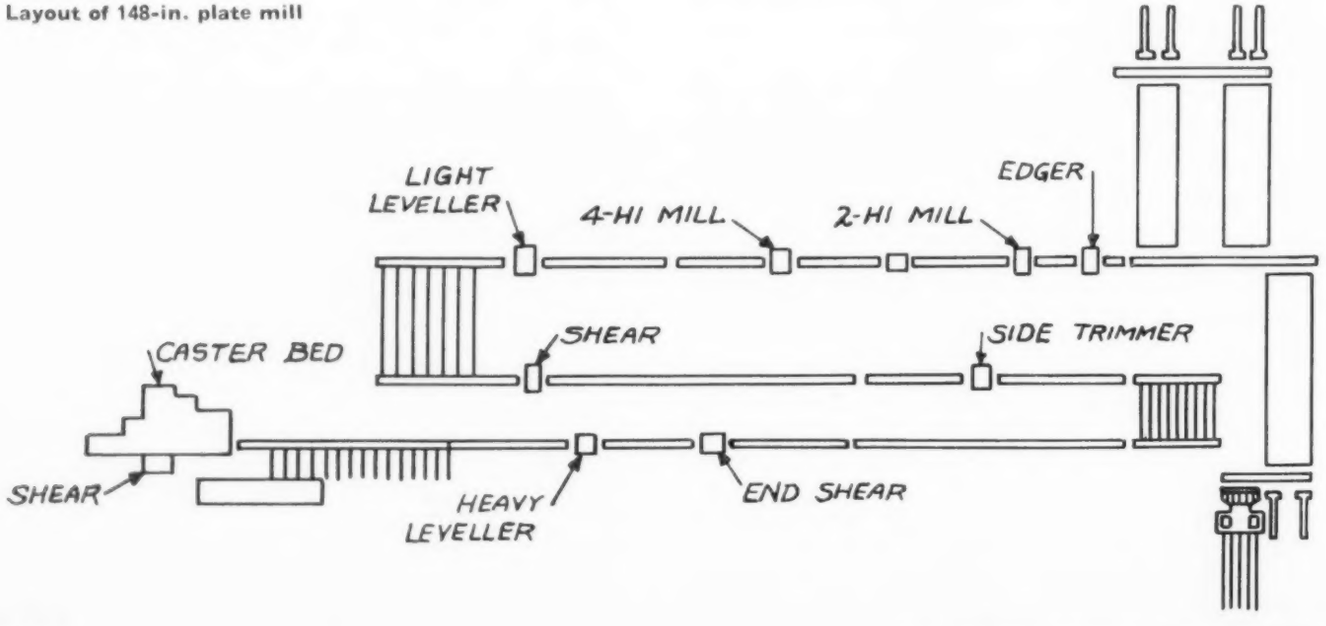
STRUCTURAL MILL

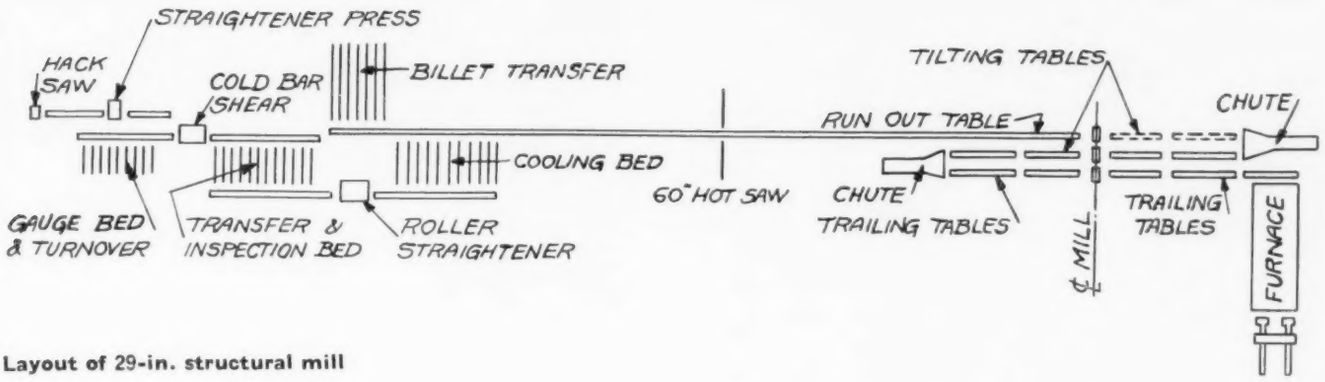
The blooming mill runout table extends on beyond the shear and transfers to the 29-in. structural mill, composed of a roughing stand, an intermediate stand and a finishing stand located side by side, all driven by a single 5000-hp, 70/150-rpm, 800-volt d-c motor. This motor receives power from a motor-generator set consisting of two 2000-kw, 800-volt d-c generators driven at 514 rpm by a 5600-hp, 6600-volt synchronous motor.

The first two mill stands are three-high, and the finisher is two-high. Traveling tilting tables 49 ft long with 60-ft trailer tables on each side of the mill handle the steel into and out of the mill stands. Chutes on both sides of the mill catch lengths that over-travel the trailer tables.

Mill housing are of cast steel, open top design. Top and bottom rolls of the three-high stands and the top

Layout of 148-in. plate mill





Layout of 29-in. structural mill

roll of the two-high stand are adjustable through manually operated screws. Rolls, with bodies 30¼ in. in diameter x 68 in. long, operate in water-lubricated composition bearings.

Billets can be rolled in this mill direct from the bloomer, but beam blanks require reheating before rerolling.

Heating for the structural mill is done in a 23 ft x 79 ft-6 in., triple-zone continuous furnace, fired with coke oven gas or fuel oil. Automatic controls are provided for temperature, fuel-air ratio and furnace pressure. Air for combustion is preheated in a tubular silicon-carbide recuperator. The charging end of this furnace extends back into the east billet yard, facilitating handling steel to the mill.

From the finishing stand, the runout table leads to a 60-in. sliding frame hot saw and gage, and on to cooling beds to the left or a billet transfer to the right. The cooling beds connect with a parallel table line leading to a roller straightener, an inspection bed, a cold shear and a piler bed. The billet transfer on the other side of the mill discharges into the west billet yard.

Steel comes to the structural mill in widths of 5½ to 17 in., thicknesses of 4 to 10 in., lengths of 14 to 21 ft, and weights of 1580 to 9565 lb. The mill produces angles of 3½ to 8 in., channels 5 to 18 in. I-beams 4 to 20 in., H-beams 4 to 8 in., wide flange beams 8 and 10 in., slabs from 5 x 3 in. to 16½ x 3 in., billets 3 to 6-in. square, and rounds, 4½, 5 and 5¼ in. in diameter. It rolls at an average rate of about 80 tons per hr, and is nominally rated at 674,000 tons per year.

SKELP AND MERCHANT MILL

This mill was originally installed in 1945 as a merchant mill with continuous roughing and cross-country finishing. It was subsequently modified when the installation of pipe mills required the production of skelp.

Heating facilities for this mill consist of one side-charge, side-discharge continuous heating furnace 33 x 50 ft, fired with coke oven gas or fuel oil. This furnace is equipped with a tile recuperator and with automatic controls on temperature, fuel-air ratio and furnace pressure. The furnace pusher moves billets down over the sloping hearth, and an ejector pusher moves the front billet out through the side of the furnace on to the mill approach table, where it may be cropped or divided by a hot billet shear.

The mill now consists of four 21-in. stands, eight 18-in. stands, two 14-in. stands and two vertical edgers. Details of these stands are given in Table VI.

Power for the drive motors of the mill comes from a 2500-kw, 600-volt, 6-phase rectifier.

When rolling skelp, No. 2 stand is dummied and the skelp leaves the mill out of No. 10 stand, giving a straight continuous layout. Skelp may be cut to length by a flying shear located just after No. 10 stand, or it may proceed to two upcoilers 275 ft away if continuous lengths are desired.

To insure good surface, water sprays at 1500-psi pressure are provided at the entry sides of No. 1, 3 and 5 stands, top and bottom.

When rolling merchant mill products, steel is taken from No. 8 stand to No. 11 and finished either out of No. 12 or No. 14, depending on the reduction required. Stands No. 11, 12, 13 and 14 are in cross-country layout, with transfers connecting the four table lines. If desired, small rounds may be looped from No. 8 stand to No. 11 and from No. 12 to No. 13 by repeaters.

Steel finished out of No. 12 stand proceeds over the runout table and across a 125-ft cooling bed. Steel finished out of No. 14 stand may be diverted to either of two pouring reels or it may pass through a rotary bar shear and over the runout table to a 250-ft cooling bed. The two cooling beds connect on to a common table line containing a cold bar shear.

All housings in this mill are of open top design.

The structural mill produces a variety of shapes, including angles, channels, I-beams, H-beams and universal plate.

TABLE VI
Merchant and Skelp Mill

Stand	Nominal size, in.	Distance from preceding stand, ft-in.	Motor, hp	Motor, rpm	Gear ratio	Roll, rpm	Roll face speed, fpm
No. 1 edger	..	...	100	300/900	41.89	7.16/21.48	...
No. 1 stand	21	9-6	300	150/300	12.6	11.9/23.8	65.4/130.8
No. 2 stand	21	28-4½	400	200/400	12.6	15.9/31.8	87.5/175
No. 3 stand	21	38-4½	500	150/400	10.5	14.3/38.1	78.8/210
No. 4 stand	21	13-0	500	150/400	7.59	19.8/52.8	109/290
No. 2 edger	..	9-4	100	500/1250	19.29	26.2/64.8	...
No. 5 stand	18	8-8	600	300/680	7.59	39.6/89.8	186/422
No. 6 stand	18	11-2	600	300/680	5.54	54.1/122.8	255/578
No. 7 stand	18	10-0	700	300/850	5.54	54.1/153.3	255/720
No. 8 stand	18	9-10	700	300/850	4.38	68.6/194.2	323/1913
No. 9 stand	18	21-6	1000	200/600	1.98	98/295	462/1392
No. 10 stand	18	16-0	1000	200/600	1.98	98/295	462/1392
No. 11 stand	18	...	1500	235/660	2.85	82.5/231.7	390/1090
No. 12 stand	18					82.5/231.7	390/1090
No. 13 stand	14	...			2.33	101/282	370/1035
No. 14 stand	14	...	500	125/375	Direct	125/375	458/1374

Roller bearings are applied to the roll necks of the vertical edgers and the first ten mill stands. Composition bearings are used in the last four stands.

When rolling skelp, slabs come to the mill 4 to 16½ in. wide x 2½ to 3 in. thick. Finished skelp runs 4.5 to 15.75 in. wide x 0.10 to 0.23 in. thick.

Other flat products 6 to 16⅜ in. wide x 0.104 to 0.375 in. thick are rolled from slabs 6 to 16½ in. wide x 2½ to 3 in. thick.

Merchant products are rolled from billets ranging from 3 in. square to 6 x 6½ in. Such products include rounds 17/32 to 4¼ in. in diameter, squares of equivalent section, round edge and spring flats 1¾ to 6 in. x 0.214 to 1.00 in., 3 and 4-in. channels and special shapes.

The skelp and merchant mill has a nominal rating of 337,000 tons per year, but rolls at an average rate of about 45 tons per hr.

COLD REDUCTION DEPARTMENT

Early in Fontana's history, a cold reduction mill was installed to finish flat material that had been rolled on the merchant-skelp mill and hot strip mill. The hot rolled material is put through a semi-continuous pickler consisting of a ¼ x 28 in. down-cut shear, coil box, roller leveler and scalebreaker, welder, a 30-ft hot water preheat tank, two 50-ft acid tanks, cold water spray tank, hot water rinse tank, dryer, shear and up-coiler. Maximum roll speed is 75 fpm.

Cold reduction is performed on a 4-high, 12-in. and 26-in. x 24 in. reversing mill driven by a 1000-hp, 600-volt, 400/960-rpm d-c motor. Each reel is driven by a 300-hp, 250-volt, 500/1450-rpm d-c motor. In line with the mill is a coil box with cover, and a pinch roll and leveler unit. Coils are originally fed into the mill through these units, and the reels handle them in subsequent passes.

The drives of this mill receive power from a motor-generator set consisting of one 1000-kw, 600-volt generator, one 1000-kw, 250-volt generator and one 250-kw, 250-volt generator, all driven at 720 rpm by a 3500-hp, 6900-volt synchronous motor. A maximum rolling speed of 1250 fpm may be attained.

This department also contains nine gas-fired cylindrical bell-type annealing furnaces with 18 bases, an 18 in. x 26-in. skin pass mill, a trimming and shearing line, a slitting line and an oiling machine.

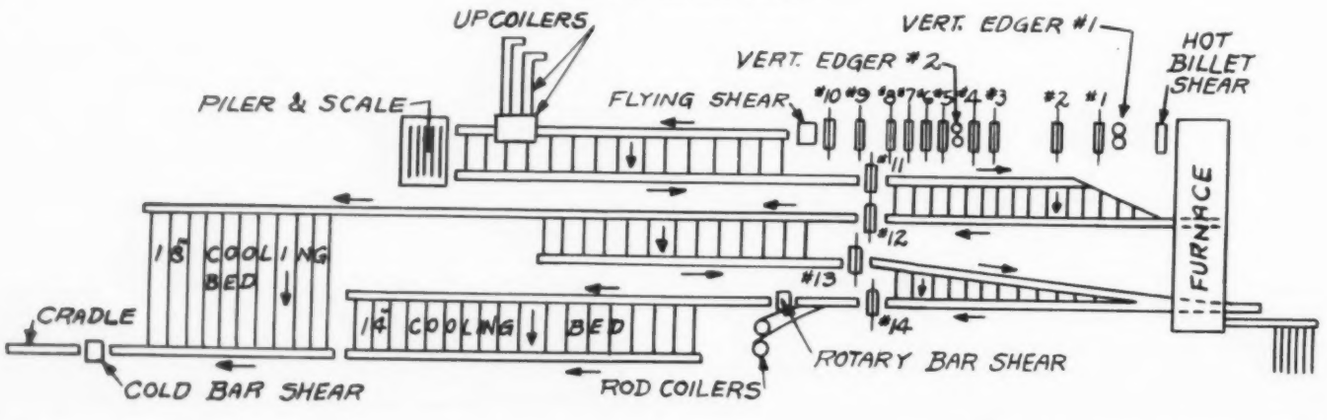
The mill capacity is approximately 5500 tons per month. Strip comes to this unit in widths of 10⅜ to 19½ in., 0.100 to 0.185 in. thick. Product runs 0.016 to 0.122 in. in thickness. Pickled and oiled product is made in widths of 6 to 16⅜ in., unslit hot rolled in widths of 10⅜ to 19½ in., and slit material in 1 to 19-in. widths.

Product may be in coils or in lengths of 48 to 120 in.

PIPE MILLS

Fontana entered the pipe field in 1948 with the installation of a continuous butt weld pipe mill and in

Layout of merchant and skelp mill.



The continuous butt weld tube mill produces pipe from ½ in. to 4 in. in diameter at speeds up to 600 fpm.

1950 added an electric weld pipe mill.

The continuous butt weld mill is designed to produce ½ to 4-in. pipe from skelp 4½ to 15¾ in. wide and 0.100 to 0.329 in. thick. Skelp may be rolled to the desired width or may be slit from wider material. The mill is of conventional layout, with coil payoff, flash welder, pinch rolls and magnet roll units feeding skelp into a continuous furnace. The furnace is 159 ft-8½ in. long x 2 ft-9 in. wide and is fired with coke oven gas. It is equipped with automatic controls for temperature, fuel-air ratio and furnace pressure, and with cast iron and alloy fin-tube recuperators.

As the heated skelp leaves the furnace at about 2450 F, air is blown on its edges, increasing their temperature to the fusion point. The skelp then passes through the mill, which consists of a forming pass, a welding pass and eight reduction passes. These stands are alternately vertical and horizontal and each stand is driven by a 15-hp, 250-volt d-c motor so as to give pipe speeds of approximately 128/600 fpm.

Following the last stand, a flying hot saw cuts the pipe into lengths which proceed over a 20 x 46-ft cooling bed and through three sizing and descaling stands, each driven by a 25-hp motor. After passing over two more cooling beds, the pipe may proceed through a straightener or over still another cooling bed to another straightener, depending on pipe size.

All drives on this mill draw power from two special motor-generator sets.

The mill averages about 17 tons per hr and has produced 11,000 tons in a month.

The electric weld pipe mill is designed to produce pipe 4½ to 12¾ in. in diameter in wall thicknesses of 0.188 to 0.406 in. from skelp 15½ to 43⅛ in. wide in 47 to 55-ft lengths.

At the entry end of the mill is a 9-roll roller leveler, followed by a shot blast unit, an end shear and a rotary edge trimmer. Next come ten cold forming passes which form the skelp into cylindrical shape.

Next comes the welding unit, in which two circular electrodes contact the edges of the formed skelp, introducing a heavy current from a special motor-generator set consisting of a 2000-kva, 480-volt, 60-cycle, single-phase generator driven at 900 rpm by a 2500-hp, 6600-volt motor. Thus, through the resistance set up by the seam where the two edges of the skelp meet, intense local heat is generated. At the same time, the pipe is kept under pressure by the electrodes on the top and welding rolls on the two sides and bottom. This combination of heat and pressure causes the edges to be welded together.

The pipe then goes through five sizing passes to obtain proper shape and size.

Except for three idler passes in the forming train, each stand is individually driven by a 20/25-hp, 300/1200-rpm, 230-volt d-c motor. These motors receive power from a 250-kw motor-generator set.

The welded pipe is then straightened, inspected, tested and prepared for shipment.

The electric weld mill will produce at an average rate of about 30-tons per hr. It has made 15,000 tons per month.

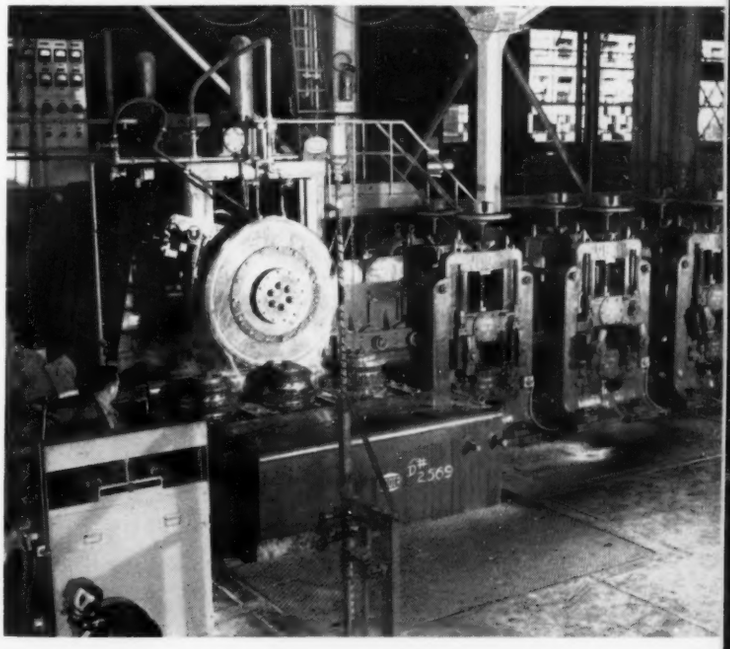
HOT STRIP MILL

The 86-in. hot strip mill, which went into operation in 1958, is designed to reduce slabs 24 to 72 in. wide, 4 to 7 in. thick and 8 ft-4 in. to 22 ft long into material ranging from No. 18 gage sheet to ⅜ in. plate, 24 to 72 in. wide.

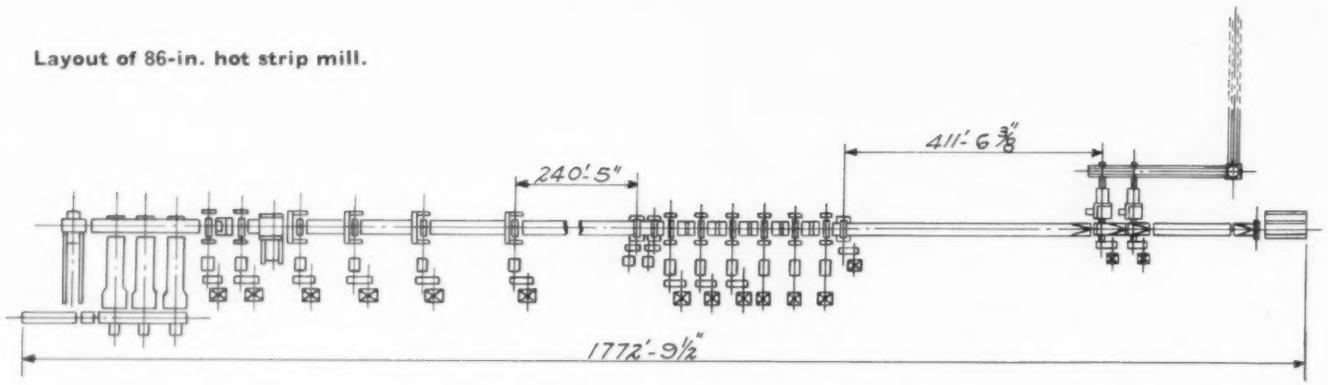
Slab storage is provided by an unroofed yard 475 x 95 ft and a roofed yard 375 x 95 ft, each served by a 25/25/15-ton crane. Slabs come from the universal slabbing mill by straddle carriers.

From storage, lifts of slabs are carried by crane, placed on a table and moved to a magazine elevator depiler, from which a pusher moves them to the furnace charging table running some 140 ft across the charging ends of the furnaces. A double rack-and-pinion type pusher driven by two 75-hp motors moves the slabs in either double or single row from the charging table into and through each furnace.

The electric weld mill is designed to produce pipe 4½ in. to 12¾ in. in diameter in wall thicknesses of 0.188 to 0.406 in.



Layout of 86-in. hot strip mill.



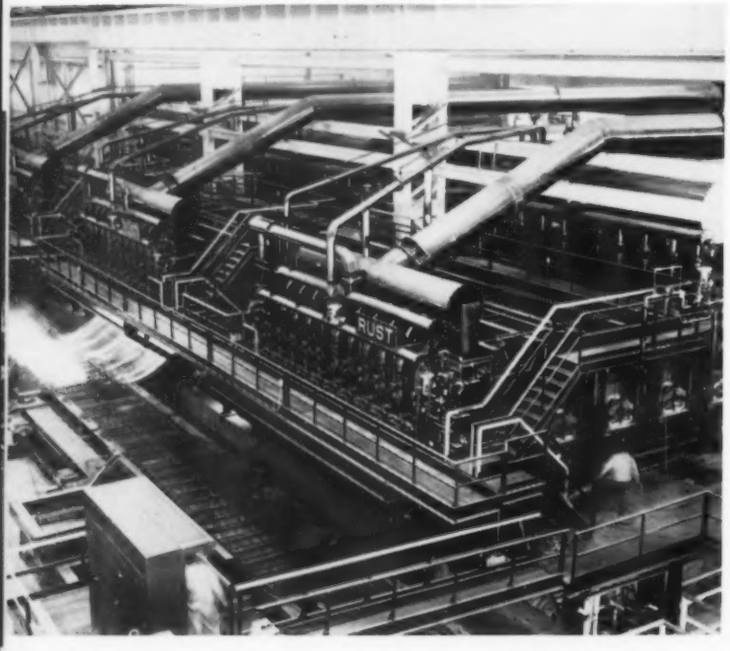
Slabs for the mill are heated in three continuous triple-fired furnaces, each rated at 150 tons per hr. These furnaces have hearths 100 ft long x 24 ft wide, and are fired with coke oven gas or fuel oil. Each of the three firing zones has individual controls on temperature and fuel-air ratio. Furnace pressure is also automatically controlled.

The furnaces are completely insulated and steel-encased. Roofs are of flat, suspended construction. Air for combustion is supplied by a fan for each furnace, rated at 52,000-cfm, 17-in. water column. Air is pushed through a needle-type cast metallic recuperator on each furnace, where it is preheated to about 700 F. Fuel consumption averages about 1,600,000 Btu per net ton of steel.

Heated slabs are expelled from the furnaces by action of the furnace pushers, slide down chutes to the furnace delivery table, where spring bumpers absorb the impact. Passing over the furnace delivery and mill approach tables, which are 208 ft long, the slab enters the roughing train, details of which are given in Table VII.

On each side of the broadside mill is a slab turntable, where slabs not exceeding 10½ ft in length may be turned 90 degrees for cross-rolling to increase width. A slab pusher at the entry side of the broadside stand assists in entering slabs between the rolls. A slab squeezer after the broadside stand squares and trues the slab after cross-rolling.

Three continuous furnaces, rated at 150 tons per hour each, heat slabs for the 86-in. hot strip mill. The furnaces burn coke oven gas or fuel oil.



The last four stands of the roughing train are equipped with vertical edging rolls about 6 ft in front of the main rolls. Vertical rolls on No. 2 rougher are driven by two motors, No. 3, 4 and 5 roughers each have one motor on the vertical rolls. All of these are 275/550-hp, 390/780-rpm, 230/460-volt d-c units, and are controlled to synchronize face speeds of vertical and horizontal rolls.

The table following the roughing train is about 240 ft long. It is composed of rollers individually driven by 3-hp d-c motors.

A rotary crop shear is located ahead of the finishing train. Between the finishing stands are loopers to take up slack in the strip between successive stands. Each looper is actuated by a torque-type d-c motor controlled from a special motor-generator set.

The work rolls of all four-high stands operate in roller bearings, while oil-film bearings are applied to the backup roll necks. All table rollers are equipped with roller bearings.

The finishing stands of this mill were originally installed following the plate mill, which served them as a rougher. Power for the six drives is furnished by four 5000-kw, 600-volt rectifiers.

Surface on the finished product of this mill is improved by hydraulic descaling sprays, top and bottom, at the roughing scalebreaker, broadside mill, No. 2 and 3 roughers, finishing scalebreaker and the second finishing stand. Water is supplied to the sprays at 1400-psi pressure by six-stage 1250-gpm centrifugal pumps.

Steel temperatures during the rolling process are checked by radiation pyrometers at No. 1 and 5 roughers, No. 2 scalebreaker, No. 11 finisher, and at the coilers. An x-ray thickness gage is installed on the exit side of the last finisher.

At the delivery end of the finishing train is a hot flying shear designed to cut lengths between 20 and 62 ft. It is driven by two 150-hp, 0/376/1100-rpm, 187/550-volt d-c motors under adjustable voltage control stemming from load relays on No. 6, 7 and 8 stands.

About 425 ft beyond the finishing train are two down-coilers with 30-in. collapsible mandrels driven by 300-bp motors and surrounded by four sets of driven

TABLE VII
Strip Mill Data

Stand	Two- or four-high	Roll diameter, in.		Roll body length, in.	Distance from preceding stand, ft-in.	Motor data			Gear ratio	Roll, rpm	Roll face speed, fpm	Screw-down motors, No. and hp
		Work roll	Back-up roll			Hp	Voltage	Rpm				
Roughing scale-breaker	2	39½	..	80	...	3000	6600 syn	150	7.23	20.7	215	(1) 50
No. 1 broadside	4	42	54	136	37–11	5000	6600 wound rotor	514	27.86	18.5	202	(2) 75
No. 2 rougher	4	42	54	89	55–10	6000	6600 syn	240	7.85	30.6	336	(2) 75
No. 3 rougher	4	34	54	89	80–0	6000	6600 syn	360	7.23	49.7	443	(2) 75
No. 4 rougher	4	34	54	89	120–0	6000	6600 syn	360	5.71	63.1	559	(2) 75
No. 5 rougher	4	34	54	89	167–0	6000	6600 syn	360	5.71	63.1	559	(2) 75
Finishing scale-breaker	2	18	..	86	240–5	75	230 d-c	410/1230	19.71	20.8/62.5	98/295	
No. 6 finisher	4	27½	54	89	24–11⅝	5000	600 d-c	125/265	4.07	30.6/65.2	217/460	(2) 75
No. 7 finisher	4	27½	54	89	19–0	5000	600 d-c	125/265	2.19	57/121	403/855	(2) 75
No. 8 finisher	4	27½	54	89	19–0	5000	600 d-c	125/265	1.46	85.6/182	604/1280	(2) 75
No. 9 finisher	4	27½	54	89	19–0	5000	600 d-c	110/220	Direct	110/220	776/1552	(2) 75
No. 10 finisher	4	27½	54	89	19–0	5000	600 d-c	125/250	Direct	125/250	885/1770	(2) 75
No. 11 finisher	4	27½	54	89	19–0	3500	600 d-c	110/290	Direct	110/290	776/2050	(2) 75
Skin pass mill	2	32	86	..	...	500	600 d-c	575/1260	10.65	53.8/118	450/985	(1) 25
Tandem cold mill												
No. 1	4	21	53	44	...	1500	600 d-c	70/210	Direct	70/210	385/1155	(2) 50
No. 2	4	21	53	44	13–0	2500	600 d-c	110/275	Direct	110/275	605/1513	(2) 50
No. 3	4	21	53	44	13–0	(2) 1500	600 d-c	175/425	Direct	175/425	969/2338	(2) 50
No. 4	4	21	53	44	13–0	(2) 1500	600 d-c	250/600	Direct	250/600	1375/3300	(2) 50
No. 5	4	21	53	44	13–0	(2) 1750	600 d-c	400/745	Direct	400/745	2200/4097	(2) 50
Temper Mills												
No. 1 stand	4	9	44	44	...	600	600 d-c	225/350	4.889	1100/1710	2600/4040	(2) 50
No. 2 stand	2	28	..	44	13–0	600	600 d-c	400/550	Direct	400/550	2932/4031	(2) 15
No. 1 stand	4	9	44	44	...	600	500 d-c	225/375	4.889	1100/1835	2600/4370	(2) 50
No. 2 stand	2	28	..	44	13–0	600	600 d-c	400/550	Direct	400/550	2932/4031	(2) 25

wrapper rolls. Pinch rolls deflect the strip into the coilers. Coils are stripped from the mandrels and transferred to a conveyor which carries them to a storage area. Coils are formed up to 60 in. maximum outside diameter and up to 35,000 lb in weight.

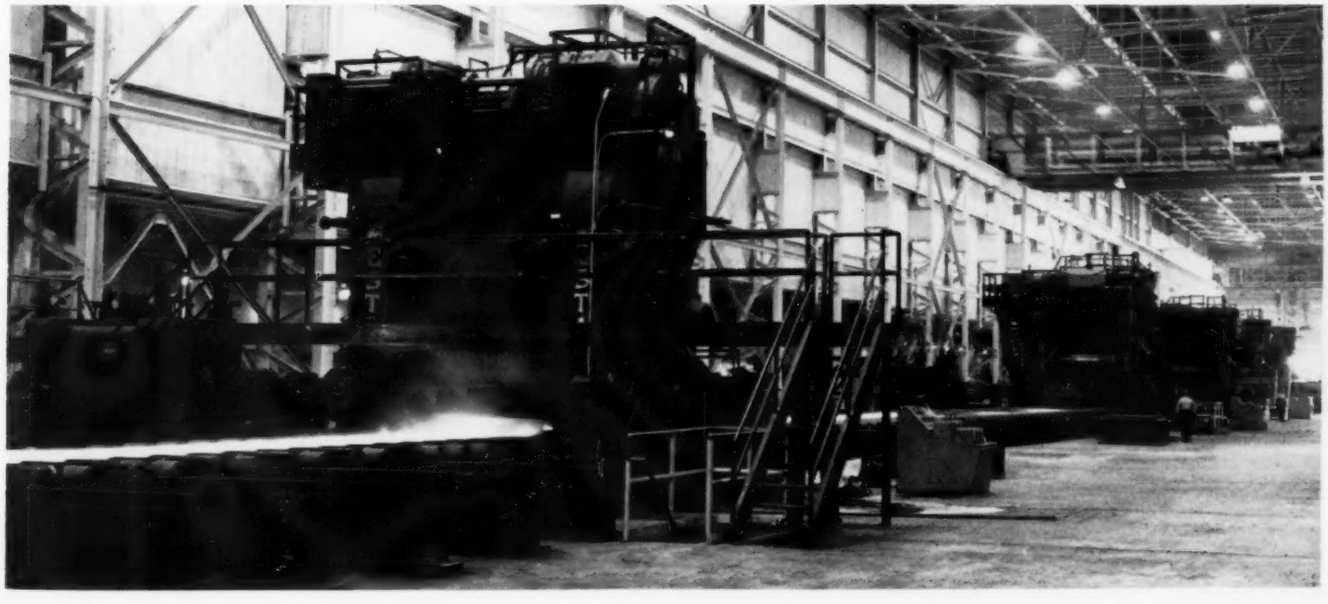
Cut lengths from the mill proceed past the coilers to a piler.

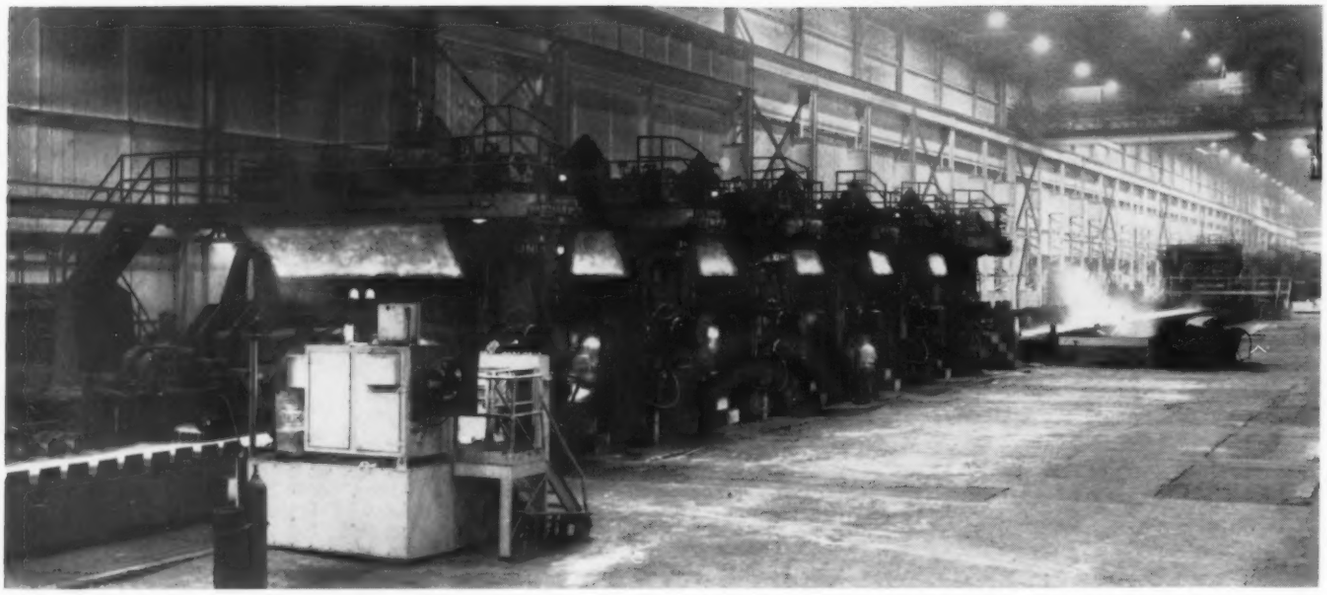
Hot mill product goes to hot rolled finished material, tinplate and tubular products in proportion of about 30, 40 and 30 per cent, respectively.

The hot strip mill is nominally rated at 1,500,000 tons per year, but rolls at rates of about 200 tons per hr.

Hot rolled finishing equipment is located at one end of the plate mill building, which formerly housed the original strip mill. Facilities here include a 32-in. x 86-in. skin pass mill (see Table VII) in line with a 76-in. roller leveler. This line processes either coils up to 56 in. outside diameter and 60 in. wide or cut lengths up to 72 in. wide and 24 ft long.

The hot strip roughing train consists of a broadside stand, followed by four roughing stands. The strip mill rolls widths up to 72 in.





The hot strip finishing train was originally installed following the plate mill, which served as a rougher. The d-c drives are powered from rectifiers.

Other processing lines include the following:

A slitting line which operates at 150/400 fpm, handling coils up to 30,000 lb in weight, widths of 18 to 54 in., gages up to $^{3}/_{16}$ in.

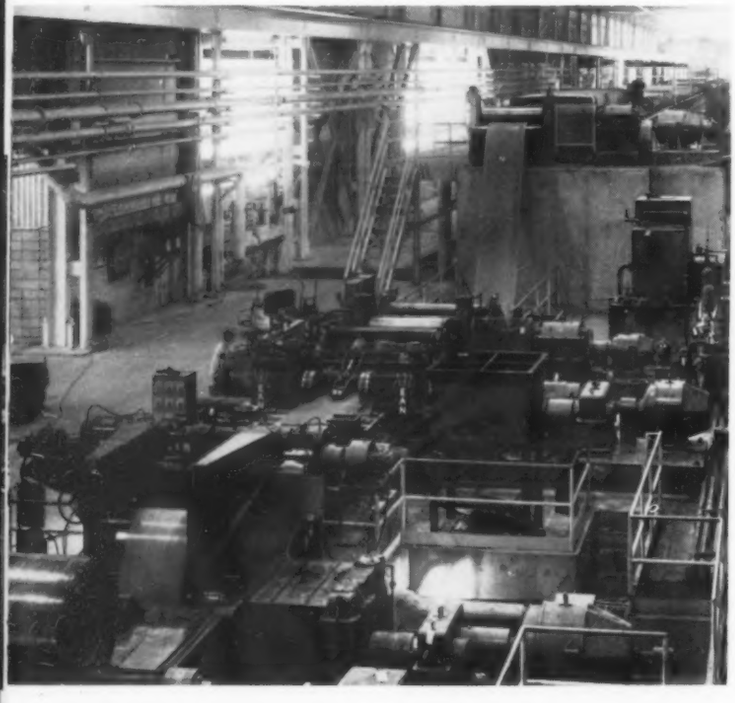
A trimming and shearing line of 100/400-fpm speed for widths up to 54 in., gages up to $^{3}/_{16}$ in., producing lengths up to 20 ft.

A trimming and shearing line of 100/300-fpm speed for widths up to 72-in., gages up to $^{3}/_{16}$ in., producing lengths up to 32 ft.

A shearing and leveling line with speeds of 200/300 fpm for cut lengths 5 to 42 ft long, up to 80 in. wide and $^{3}/_{8}$ in. thick.

A $^{3}/_{16}$ x 156-in. squaring shear.

View of the exit end of the continuous 50-in. pickling line, which has a maximum tank speed of 600 fpm.



TIN PLATE DEPARTMENT

The tin plate mill, originally built in 1952, was expanded in 1954 and again in 1958. These facilities are located in a building adjacent and parallel to the new hot strip mill. The tin mill now includes a 50-in. continuous pickling line, a 5-stand 21-in. and 53-in. x 44-in. cold reduction mill, a 38-in. electrolytic cleaning line, seven four-stack annealing furnaces with twenty-one bases, one single-stack annealing furnace with three bases, a 38-in. continuous annealing line, two two-stand temper mills, two 38-in. coil preparation lines, two 38-in. electrolytic tinning lines, seven hot dip tinning lines and two 38-in. shearing and classifying lines.

Hot rolled coils are brought from the raw coil storage area to the entry end of the pickle line by overhead crane, up-ended and delivered by conveyor to the uncoiler. The strip then passes through an up-cut shear, flash welder and trimmer, looping pit, processor, hot water spray tank and into the first of four pickling tanks.

The four tanks are 80 to 81 ft-6 in. long x 6 ft-5$^{1}/_{4}$ in. wide x 5 ft-1 in. deep. Each holds approximately 13,500 gal of sulphuric acid solution. Acid strength is 5 per cent in the first tank, 10 per cent in the second, 15 per cent in the third and 20 per cent in the fourth. The tanks, of steel construction, are lined with rubber and three courses of acid-resistant brick. Tank covers are of rubber-covered steel and are vented to continuous exhaust headers. Fans draw the fumes through these headers to a fume eliminator located below a 60-ft exhuast stack. Steam jets automatically maintain pickling solution temperatures at about 200 F.

Leaving the pickling tanks, the strip then passes through a cold water spray, a hot water rinse tank, a hot air dryer, another looping pit, an upcut shear, a side trimmer and then to the up-coiler.

The pickle line has a maximum entry speed of 1500 fpm, a maximum exit speed of 750 fpm and a maximum tank speed of 600 fpm.

The cold reduction mill is a five-stand unit (see Table

VII) designed to reduce strip 0.080 to 0.187 in. thick and 18 to 38 in. wide down to a minimum gage of 0.007 in. Coils are delivered to the mill entry ramp by ram lift trucks. A coil rotating rig, coil box, guides and pinch rolls handle the steel as it enters the mill. Work rolls are forged steel or cast iron and run in roller bearings. Backups are cast steel and operate in sleeve-type oil-film bearings.

Leaving the last stand, the strip is coiled on a 16½-in. diam mandrel driven by two 400-hp, 225/1000-rpm, 300-volt d-c motors in series. Strip is guided around the mandrel by a hydraulically operated belt wrapper. When the coil is through the mill, the mandrel is collapsed and a carriage lifts the coil and moves it at right angles to the mill line to a delivery ramp for removal by ram lift truck.

Automatic gage control on this mill is maintained by a beta-ray gage after No. 1 stand controlling No. 2 stand screwdown position, and an x-ray gage after the last stand controlling the speed of No. 5 stand and recording final strip thickness.

The drives of the cold mill receive power from two motor-generator sets, one having a 1200-kw generator for No. 1 stand, a 2000-kw generator for No. 2 stand and a 2400-kw generator for No. 3 stand. The second set contains a 2400-kw generator for No. 4 stand, two 1400-kw generators for No. 5 stand and a 640-kw generator for the tension reel. All of these generators are 600-volt d-c, and each set is driven by an 8200-hp, 514-rpm, 6600-volt synchronous motor.

The tandem mill operates at a rate of 62.5 tons per hr. It is rated at 468,000 tons per year.

One electrolytic cleaning line is available to remove the oily residue from the cold-reduction operation. This line operates at speeds up to 2000 fpm. Current is supplied to the electrolytic equipment by two 75-kw, 12/30-volt d-c generators.

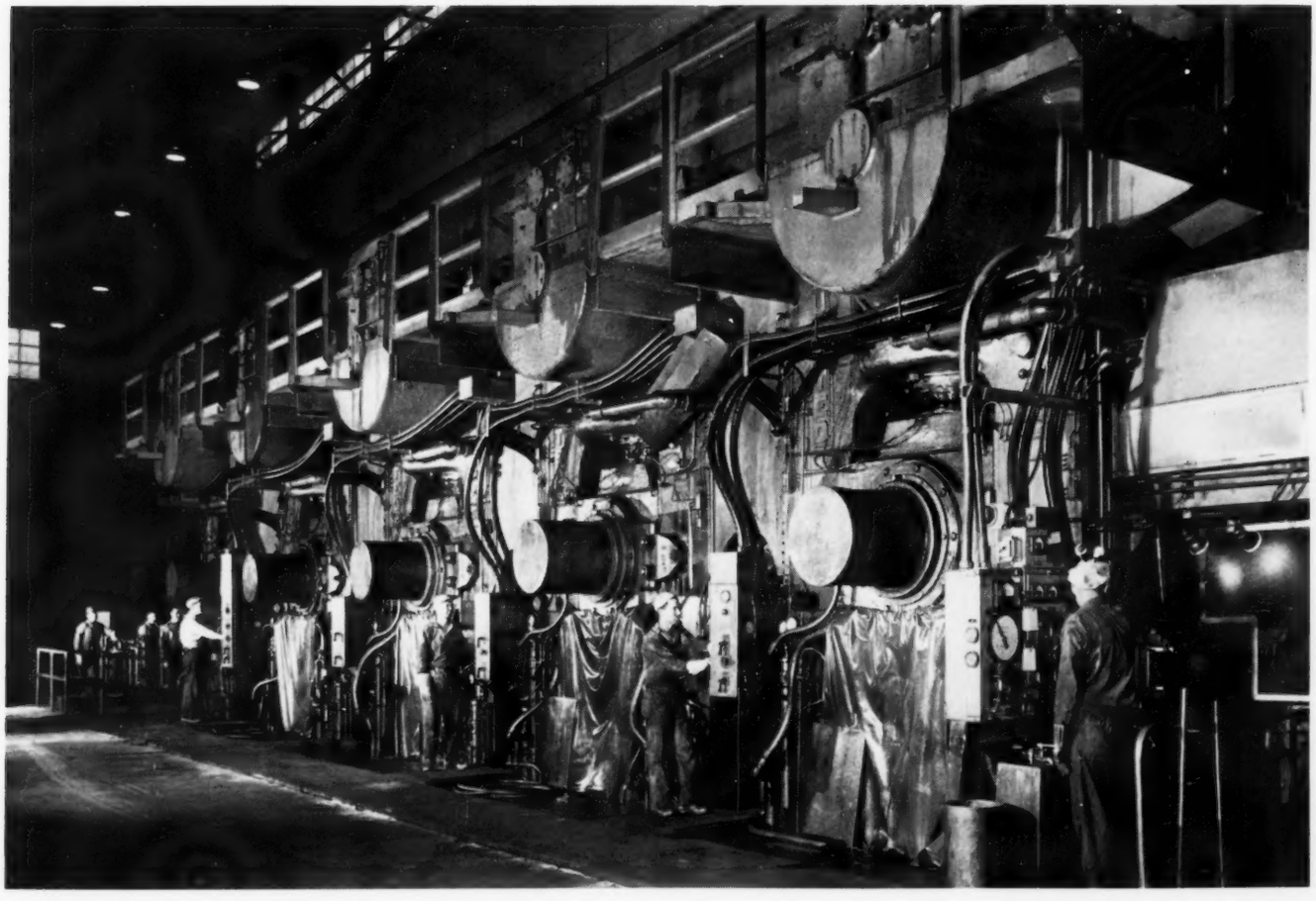
There are seven box type, radiant tube annealing furnaces, 7 ft-6 in. wide x 31 ft-8 in. long x 14 ft high and 21 furnace bases. Each furnace will take four stacks of five coils, for a total charge of about 460,000 lb. An inner cover protects each individual stack. The furnaces are fired with coke oven gas through high-pressure burners. Fuel consumption averages 1,250,-000 Btu per ton. There is also one single-stack furnace with three bases.

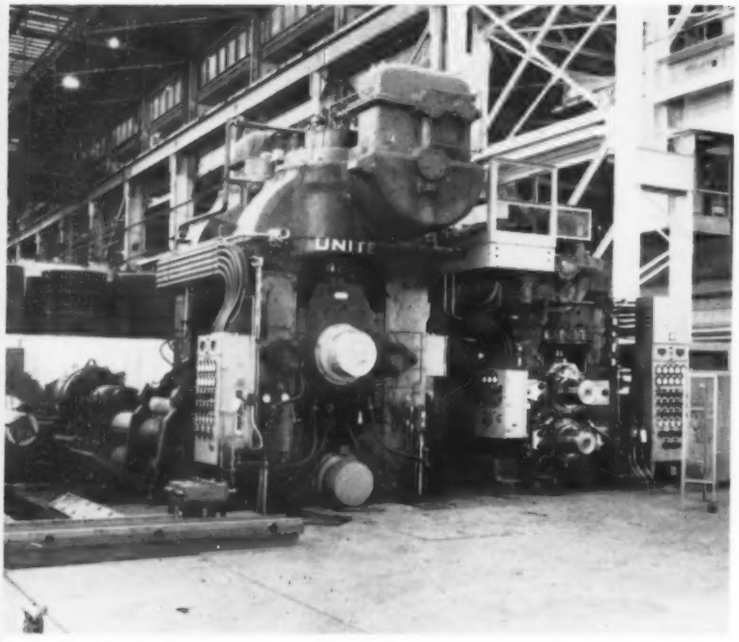
Annealing facilities were expanded in 1958 with the addition of a continuous annealing line. In this unit coils are paid off through a welder and into the cleaning section, which consists of an alkali dip tank, a scrubber, two electrolytic cleaning tanks, a second scrubber, spray rinse and dryer. Next is a looping tower, after which strip enters the furnace section.

The heating section, which accommodates six strands (315 ft) of strip, is heated with coke oven gas. It is followed by the electrically heated holding zone, which holds six strands (300 ft) of strip. Next is a slow cooling section, also electrically heated and also with six passes (300 ft) of strip. The fourth section, which holds eight passes (400 ft) of strip, is equipped with water-cooled surfaces for rapid cooling. Finally, the strip passes through a quench tank, a dryer, a looping pit, a shear and two recoiling reels.

The line operates at speeds up to 1200 fpm. A typical

Strip 18 to 38 in. wide is cold reduced in this five-stand tandem mill to gages down to 0.007 in. Production averages 62.5 tons per hour.





This two-stand temper mill makes a light reduction on the strip to impart flatness and stiffness.

operating cycle might have a heating zone temperature of 1650 F, bring the strip up to 1350 F. The holding section might be 1350 F. Temperature might drop to 900 F in the slow cooling section and to 600 F in the fast cooling section. Water quenching pulls the temperature down to 150 F. Production averages about 30 tons per hr.

Two 20,000-cfhr gas generators provide protective atmosphere for the continuous anneal.

After annealing, strip is put through either of two two-stand temper mills to obtain the flatness, hardness and surface desired in the tin plate. These units consist of a four-high and a two-high stand in tandem (Table VII). The four-high stand is driven through its backup rolls. Drives on these mills draw power from two motor-generator sets, each consisting of two 1000-kw, 600-volt d-c generators driven by a 2800-hp, 720 rpm, 6600-volt synchronous motor.

Coils are brought to the temper mills by overhead crane. A coil car places them on the payoff reel. The strip then passes through an entry tension unit with 20-in. tension rolls and 8-in. hold-down rollers. At the delivery end of the mill is a duplicate tension device, a reel with belt wrapper, a stripper mechanism and coil car, and a delivery conveyor.

The black plate is now ready for tinning. If it is to be hot dipped, coils are put through a shearing and classifying line, where they are side-trimmed, cut to lengths of 18 to 43 in. and automatically separated by a pinhole detector and flying micrometer into primes and rejects. Seven 75-in. hot dip tinning lines are installed to handle sheets 0.006 to 0.024 in. thick, 16½ to 34 in. wide and 18 to 40 in. long. These units employ vacuum cup type mechanical feeders and include an electrolytic pickling tank, tinning machine and pot, wet washer, branner and an inspection, assorting and piling unit.

If the material is destined for electrolytic tinning, coils go to either of two coil preparation units, where they are side trimmed and built up into the desired coil size. X-ray gages in these lines check on strip thickness.

Electrolytic tinning is done in either of two lines, one installed in 1952, the other in 1958. Both use the conventional acid process, and are capable of handling coils up to 66-in. outside diameter, 38 in. in width and 30,000 lb in weight. Maximum speeds of the two lines are 1000 and 1250 fpm, respectively.

Coils are brought by overhead crane and placed in coil cars which center the coils on the proper pass line. Strip first passes through a shear, a double seam lap welder, a looping pit and an entry tension bridle, before entering the cleaning and pickling section. Here the strip passes through an alkaline solution, water rinse, pickling solution, water rinse and a final spray rinse.

The plating sections contain vertical rubber-lined tanks (ten in No. 1 line, six in No. 2 line) about 10 ft deep, followed by another tank which collects solution carried over by the strip. Pure tin anodes are used in the acid-type solution, with the strip acting as the cathode.

Strip then passes through an electric conduction type reflow unit, a water quench tank, chemical treating tanks, rinse tank, dryer and oiler. A thickness gage and pinhole detector automatically inspect the tinned strip before it is recoiled.

Coils of tinned strip may then be put through a shearing and classifying line if the product is desired in cut lengths.

FABRICATING DIVISIONS

Kaiser Steel Corp. has three fabrication plants which are located at Napa, Montebello, and Fontana, California.

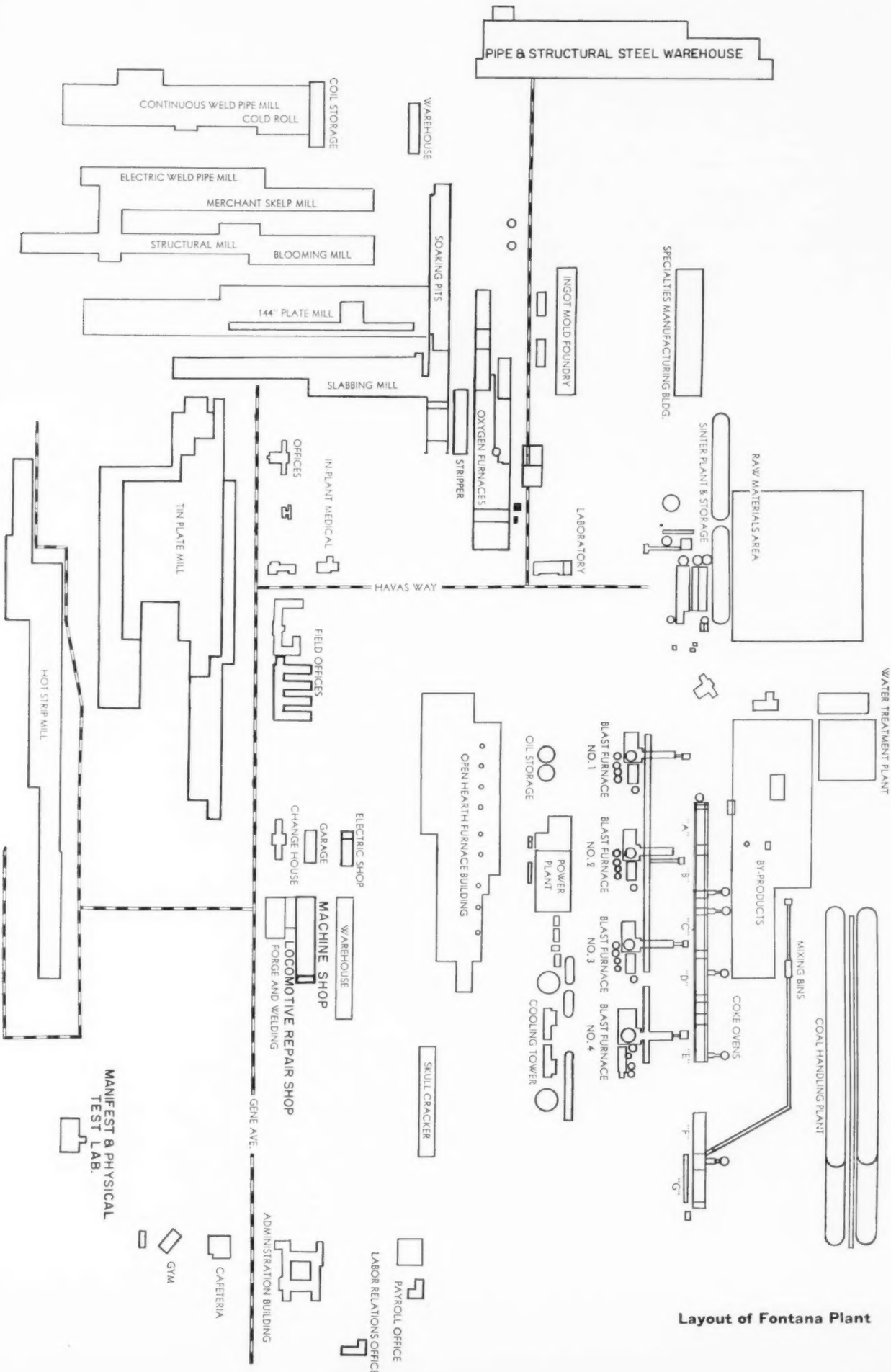
The Napa plant generally handles production of medium and large diameter pipe, fabrication of machinery, barges, pressure vessels, tanks and other products. Two electric weld pipe mills, with a combined capacity of 540,000 tons per year, produce pipe of 6⅝ to 42 in. outside diameter.

The plant at Montebello handles construction and erection of bridges, freeway structures, buildings, missile and rocket testing towers, railroad car underframes, and other products for the aircraft industry and Armed Forces.

The fabricating plant at Fontana produces heavy wall segmental-section steel pipe, reinforced concrete pressure pipe and other assemblies sold mainly for aqueducts, pipelines, and hydraulic penstocks. The plant is also engaged in the shaping of thick steel plate and in general steel fabrication work.

SERVICE DEPARTMENTS

Quality of raw materials and products is controlled by chemical, metallurgical and inspection departments, employing about 360 people. These groups are set up in five divisions. The chemical division operates several laboratories devoted to checking raw materials and products throughout the plant and to special research. The steelmaking and primary mills division observes practices and sets up procedures in these areas. The rolling mills division covers the process control, testing and inspection of hot rolled products from the secondary mills. The tin mill and cold rolled strip division per-



Layout of Fontana Plant

forms similar functions for the tin mill, and the tubular products division for the tube mills.

The metallurgical engineering department analyzes all orders and specifies the processing to be given. It also carries on the physical testing and handles complaints and general customer liasion work.

Shop facilities include the usual machine, forge, welding, pipe, electric, boiler car repair and locomotive shops, as well as a carpenter, paint and pattern shops, and a foundry equipped for pouring hot metal from the blast furnaces. The foundry produces ingot molds and other castings for plant use and for outside sale.

Furnace maintenance and ladle lining are carried out by the masonry department. Refractory supplies are generally received on pallets for economy in storing and handling. Four refractory storage buildings accommodate a three-month inventory.

Four roll shops are located at strategic spots in the plant. The main shop contains eight roll lathes, 26 to 60 in., and two 24 x 96-in. grinders. At the plate mill are a 60-in. lathe and a 60 x 264-in. grinder. The strip mill shop has three roll grinders and the tin mill shop has six roll grinders and a grit blasting machine.

Within the Fontana plant, some 90 miles of standard gage track provide for inter-plant transportation. Mobile equipment includes 17 diesel locomotives of 80 to 124-ton, 17 yard cranes of 10 to 60 tons, three $3\frac{1}{2}$-yard shovels for handling slag, 235 gondola cars, 150 flat cars, 90 dump cars, 41 hopper cars and 23 mixer-type hot metal ladles.

The plant is served externally by the Southern Pacific and Atchison, Topeka and Santa Fe railroads.

UTILITIES

Electric power, purchased from the utility company serving the district, enters the plant over three 67,000-volt, 3-phase, 60-cycle transmission lines sized at 653,000 circular mills, of steel-reinforced aluminum cable. Separate overhead lines carry the power to three primary substations. Switching is designed to insure operation of all stations even with the loss of one transmission line.

The largest substation contains a bank of 67,000/6900-volt transformers totaling 70,000 kva, connected Y-delta. The 6900-volt power is distributed to load centers at the plate mill, slabbing mill, blooming mill, structural mill, pipe mills, merchant mill, oxygen steel plant, tin mill and foundry.

The other two primary stations are identical, each having two 15,000/20,000-kva, 67,000/6900-volt transformers, connected delta-Y. One station serves the hot strip mill; the other distributes to the power house, coke plant and No. 4 blast furnace.

All primary substations have a double bus system, with all 6900-volt secondaries grounded through a resistance network.

Where required, power is reduced to 2300 and 480 volts. In general, 6900-volt power is used for distribution and motors of 1000 hp or larger. A-c motors between 250 and 1000 hp are usually 2300 volt, as is some secondary distribution. Motors smaller than 250 hp are generally 480 volts.

Direct current at 250-volts is supplied for mill auxiliaries principally by 14 rectifiers ranging from 500 to 2500 kw in capacity, totaling 14,500 kw. There are also three 1000-kw and one 400-kw motor-generator sets.

The entire plant sets up an average operating load of about 95,000 kw. Energy consumption will run about 380,000,000 kwhr per year.

Steam for the plant is provided from two producing centers. The power house contains seven boilers which operate at 400-psi pressure, 700 F. One unit is of 105,000-lb per hr capacity, four of 160,000-lb per hr and two of 300,000-lb per hr. These ratings are based on coke oven gas or oil. Capacities with blast furnace gas are approximately two-thirds of these.

The boilers are fired primarily with blast furnace gas, with standby facilities for coke oven gas or fuel oil. They are equipped with full automatic control.

In addition there are nine fire-tube waste heat boilers at the open hearth which generate 22,000 lb of steam per hr each, at 175-psi pressure, 450 F.

Steam is used for the turboblowers in the power-house and for process work in the entire plant.

Water for the Fontana plant comes from a company serving the area and from two 2000-gpm deep wells on the plant property. As water is not plentiful, conservation is carried to a high degree with extensive recirculation.

The raw water is treated with lime and sodium aluminate, chlorinated recarbonized and filtered, and then flows into either a covered domestic reservoir or an industrial reservoir. The former supplies water for drinking, sanitary purposes, power house use and fire protection. Waste water from the domestic system passes through a sewage treating plant, with the effluent going to the industrial system.

The industrial reservoir supplies water to a number of individual water systems provided with cooling towers and recirculating pumps. Each system operates on a certain type of service, such as cooling in motor rooms and reheating furnaces, cooling of mill bearings and rolls, cooling of steelmaking furnaces, blast furnaces and coke plant equipment, and cleaning of blast furnace gas. Normally, all make-up water goes into the first application, serving motor rooms and reheating furnaces. Make up for each successive application as listed comes from the application immediately preceding it.

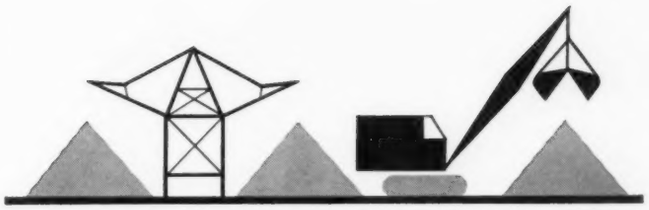
Pumping requirements have been reduced materially by using water through several applications in series. This permits higher water velocities, which has reduced the build-up of solids while reducing water usage and improving the operation of the cooling towers.

As a result of these conservation measures, over-all make-up to the entire system runs only about 5000 gpm. Also, waste water to be disposed of is held to a minimum.

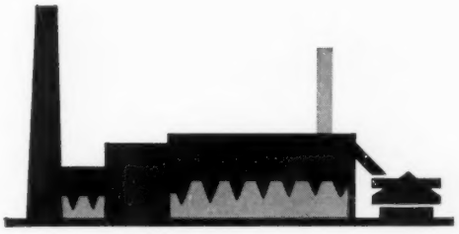
Boiler feed water comes from the domestic reservoir and is put through zeolite softeners before use.

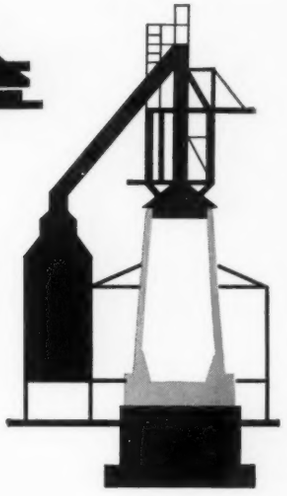
High purity oxygen for the basic oxygen furnaces and other plant uses comes from a vendor's plant nearby. It has an annual capacity of 3,790,342,500 cu ft.

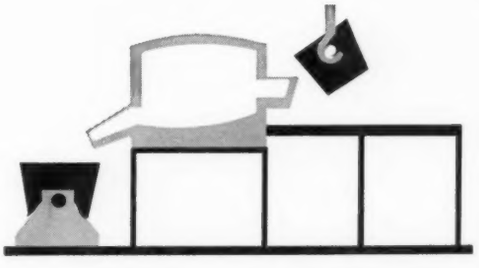
With full operation, monthly fuel usage of the plant, excluding the coke ovens, approximates 1,297,000,000 cu ft of coke oven gas, 78,800,000 cu ft of natural gas and 4,423,000 gal of fuel oil. Another 300,000,000 cu ft of coke oven gas is used for firing the coke ovens. ▲

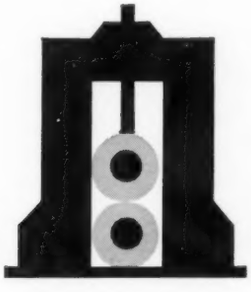


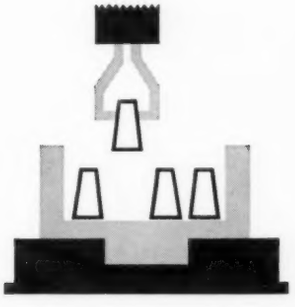
The fully integrated facilities at Fontana, designed and built by Kaiser Engineers, exemplify the complete engineering-construction services KE provides the steel industry throughout the world. KE steel plant services include: all types of studies, site planning, general design engineering, preparation of cost estimates and specifications, special process and equipment design, detail design, procurement and expediting, construction, cost control, operator training and initial start-up.

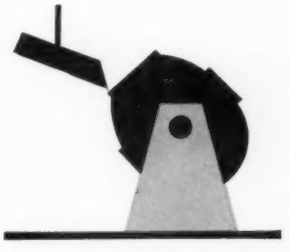












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Oakland 12, Calif. — Chicago, New York, Pittsburgh, Washington, D.C.
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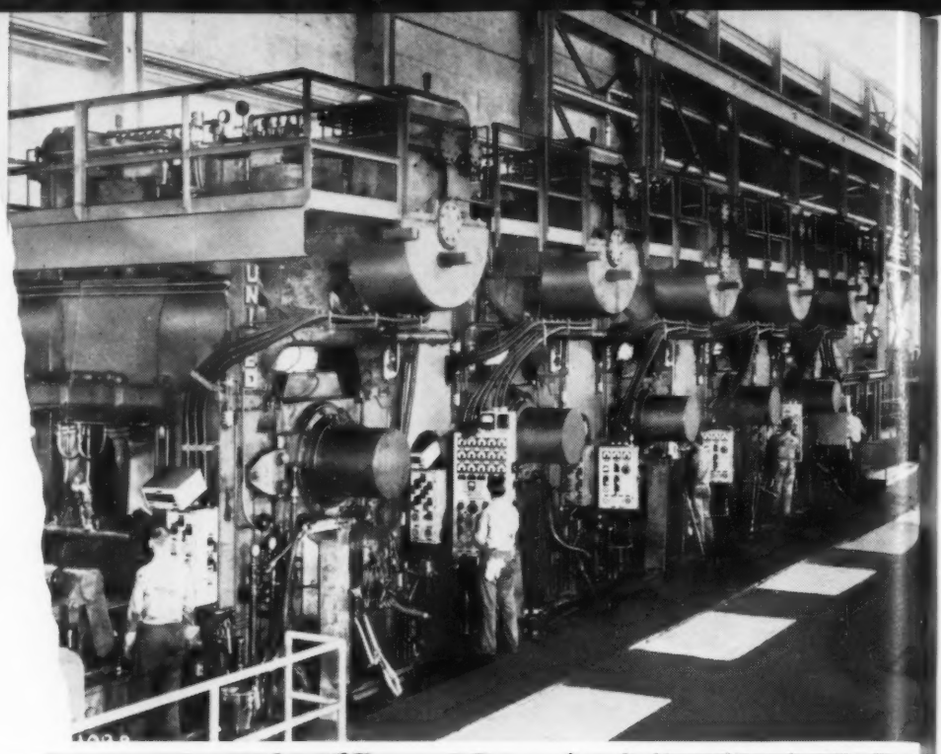
6909A

21" & 52" x 48", 5-Stand 4-High, Cold Mill

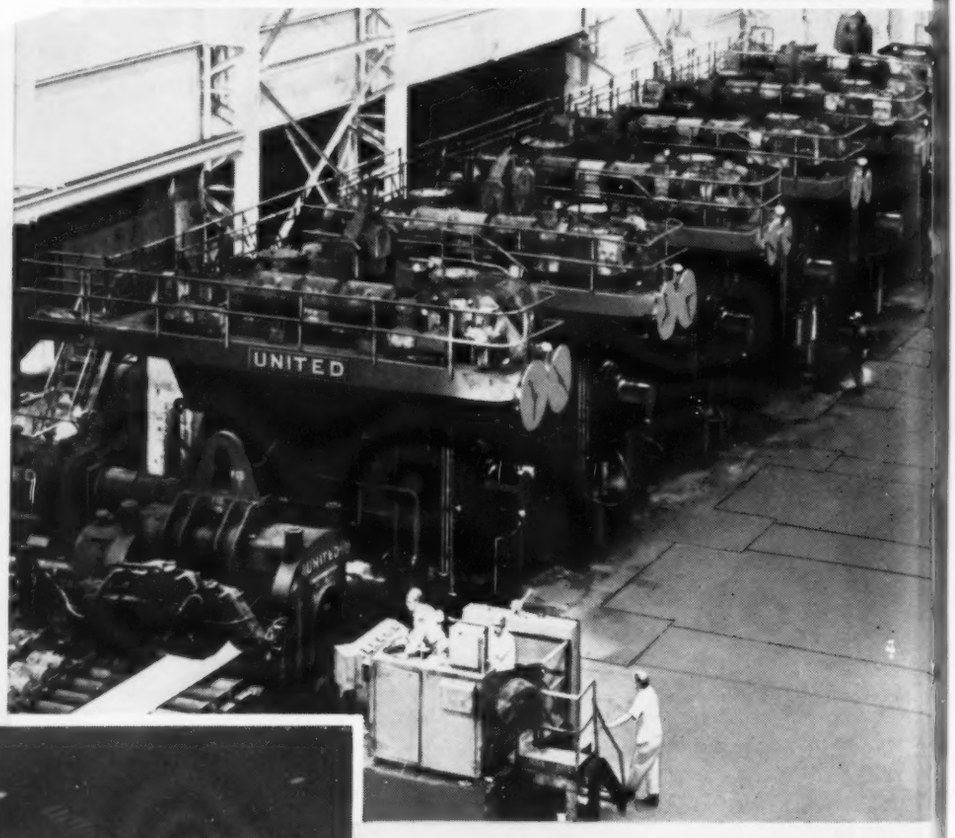


UNITED® MILLS

Designed and Built for

KAISER STEEL CORPORATION

Fontana Works
California



UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh • Vandergrift • Youngstown
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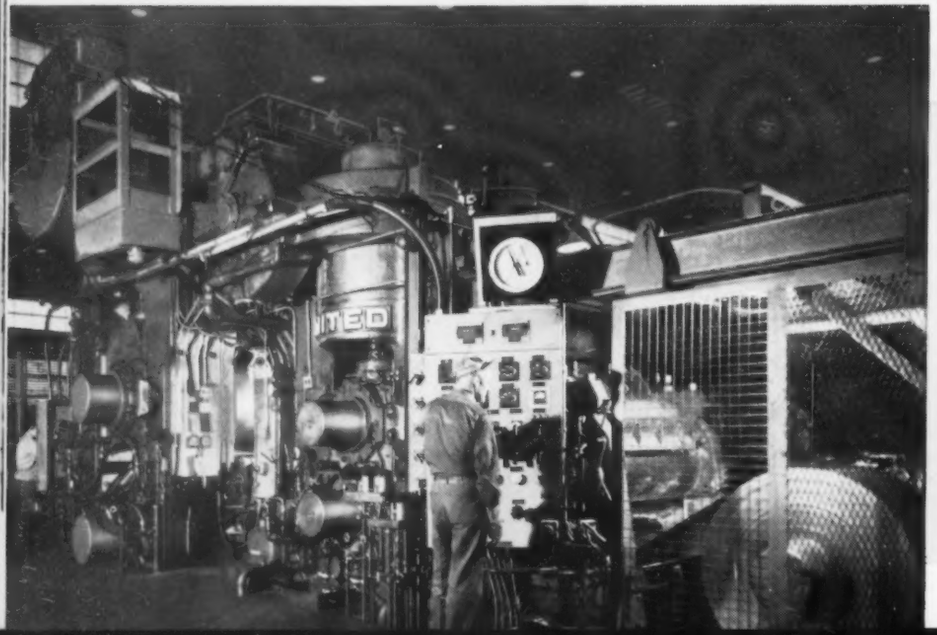
SUBSIDIARIES: Adamson United Company, Akron, Ohio
Stedman Foundry and Machine Company, Inc., Aurora, Indiana

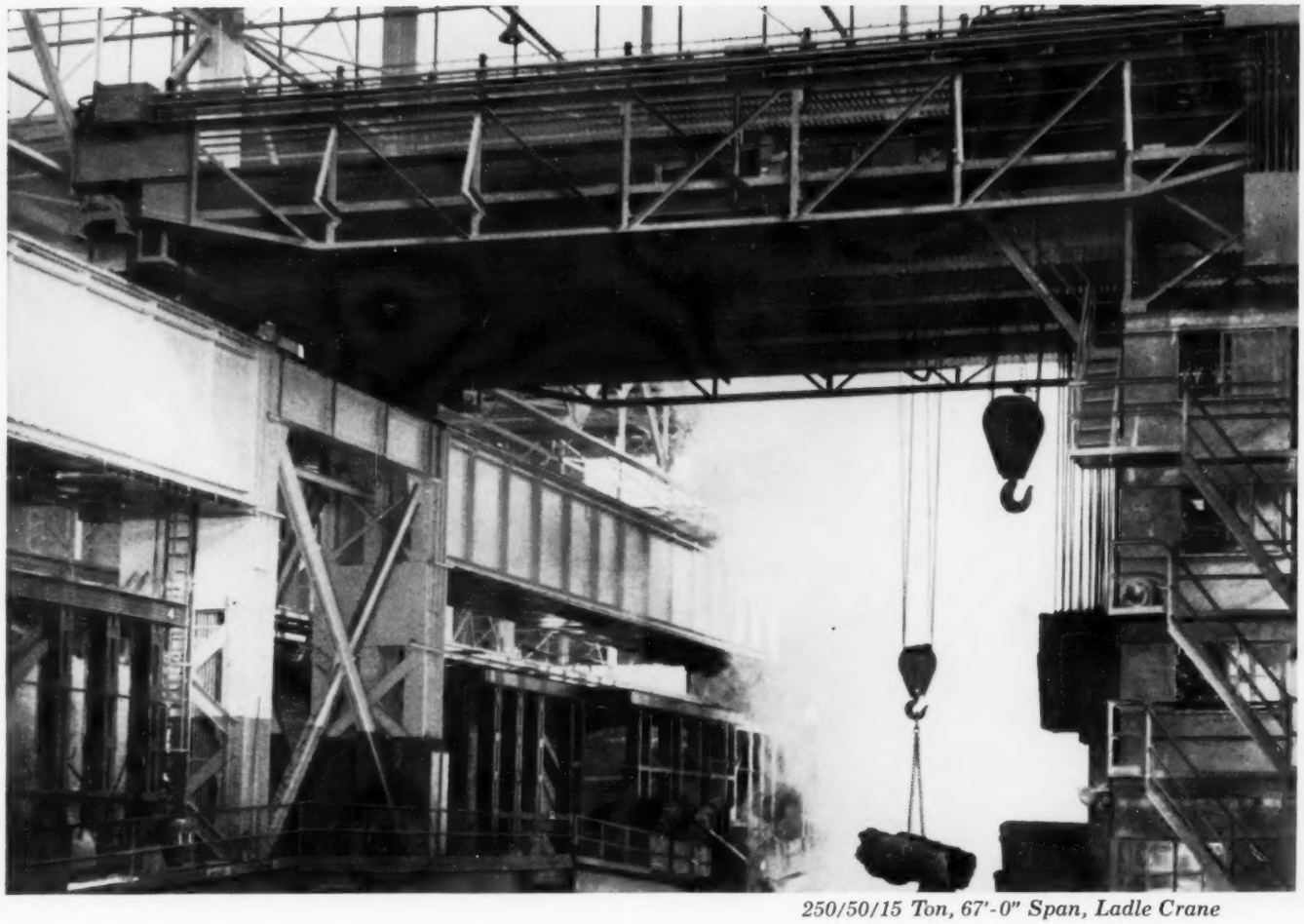
Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.



27" & 54" x 86", 4-High, Hot Strip Mill

44", 4-High and 2-High, 2-Stand Temper Mill

(Two of these mills in operation)



250/50/15 Ton, 67'-0" Span, Ladle Crane

At Kaiser's Fontana Works...

METAL IS KEPT MOVING WITH MORGAN CRANES

Highly efficient, dependable Morgan cranes help keep production moving smoothly at Kaiser Steel Corporation's Fontana, California, works.

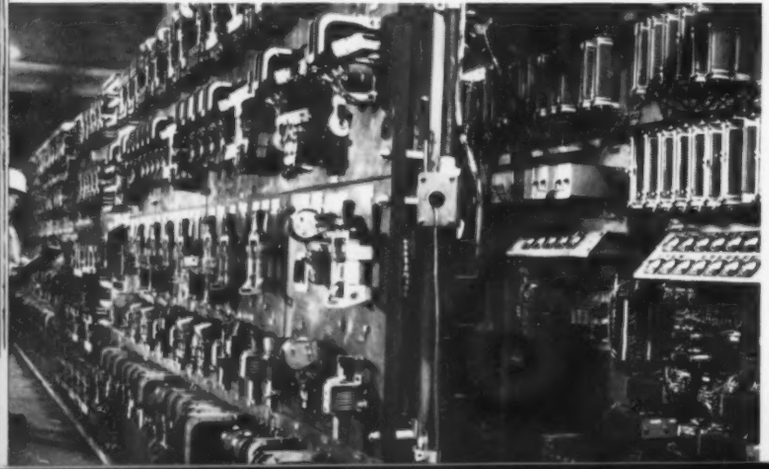
In making plans for mill modernization or expansion, put a Morgan Engineering representative on your planning team. He'll give you facts on Morgan cranes and other Morgan mill equipment that will assist in speeding production and lowering your costs.

THE MORGAN ENGINEERING CO. *Alliance, Ohio*

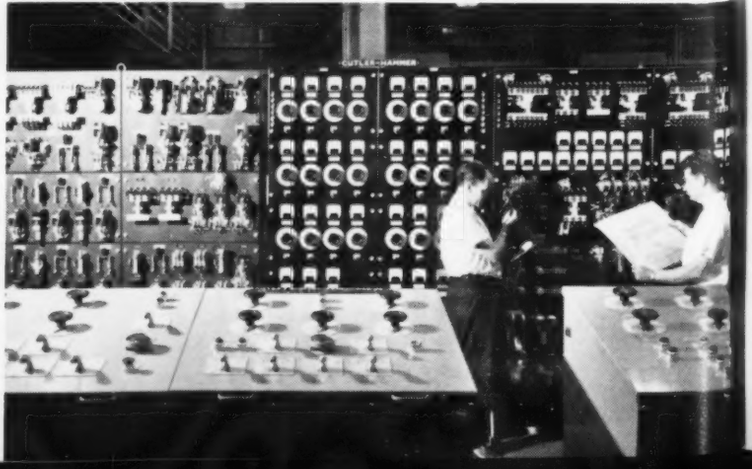
E.O.C.I. MEMBER

Overhead electric traveling cranes, gantry cranes,
open hearth special cranes, blooming mills, structural mills,
shears, saws, auxiliary equipment and welded fabrications.

Cutler-Hammer Control. Shown here, the control of 87 D.C. motors, employing 16 static regulators. Kaiser annealing line control system also regulates 45 A.C. auxiliary motors; requires 10 operators' stations and more than 300 meters, pushbuttons, master switches, potentiometers and operating lights.



Cutler-Hammer Test Floor. Here, complete factory tests of systems control prior to shipment insure faster installation, more trouble-free start-ups. Analog computer-simulator can test engineering solutions before construction; simulate response of any motor or machine to aid in actual factory tests.



What's new in systems control?

Cutler-Hammer Control commands 1600 h.p. High Speed Annealing line at Kaiser Fontana

Big D-c system meets demanding requirements on 1200-FPM line

The responsibility for making the block-long system of huge equipment in a modern annealing line function continuously and in perfect step falls on control engineering. For this responsibility, including all control and rotating equipment, Kaiser selected Cutler-Hammer in the recent expansion of its Fontana works.

The problem: a continuous flow of steel strip through entry, furnace and recoil sections . . . through looping towers on each side of the furnace . . . at 1200 to 1500 FPM!

Laboratory testing speeds trouble-free start-up

Each step posed a critical control problem. Yet Cutler-Hammer's systems and control engineers bound the whole into a smoothly operating team. The entire system was pre-tested in Cutler-Hammer laboratories. Result: Kaiser-Fontana reaped the benefits of a more complete test, quicker installation, and a faster, more trouble-free start-up. Kaiser today produces the uniform quality tinplate demanded by its customers.

Cutler-Hammer control systems and equipment were installed on seven of the first nine high-speed annealing lines built. Cutler-Hammer engineering and equipment is also at work on the Fontana pickling line, coil preparation line, and in auxiliaries for slabbing, hot strip and temper mills.

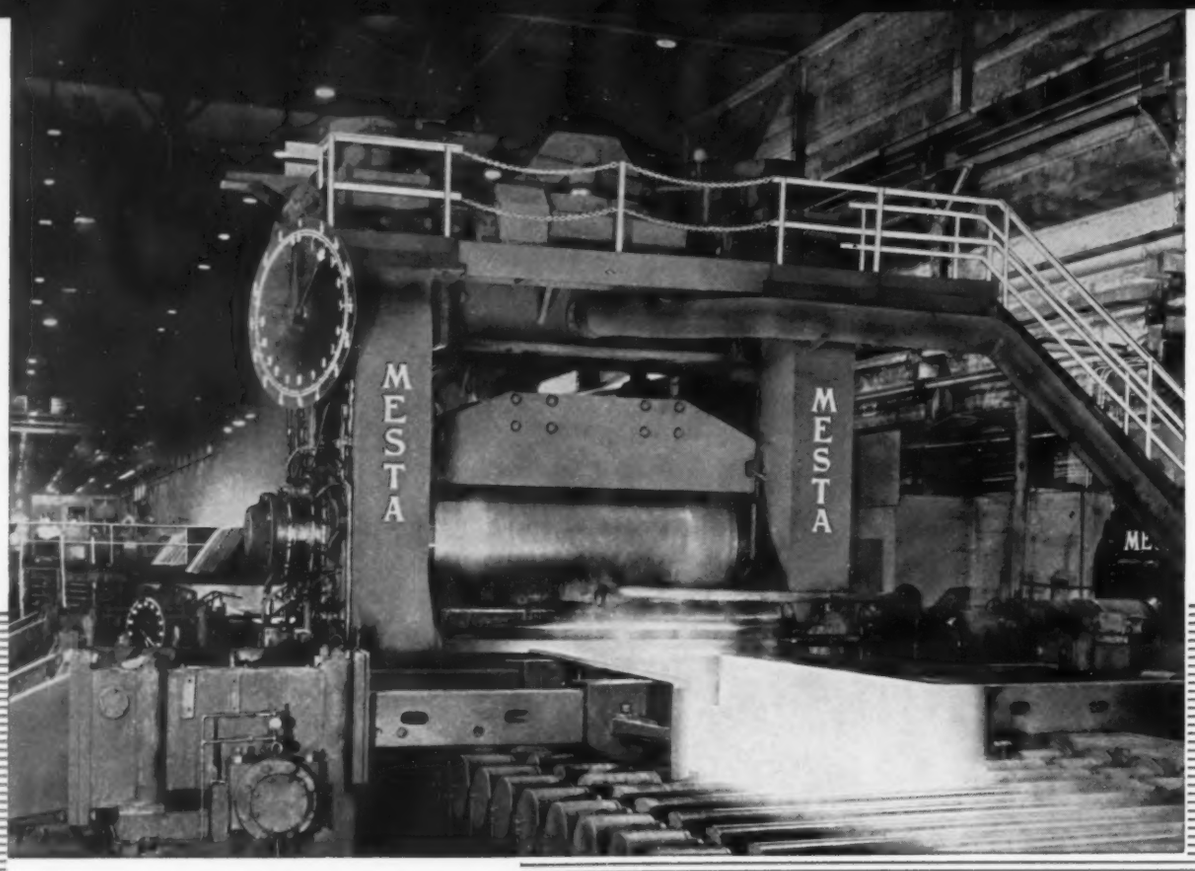
Call the C-H man . . . early!

Cutler-Hammer's broad experience in all phases of systems control design means the Cutler-Hammer man brings a knowledgeable eye to your particular control problem. Cutler-Hammer procedures insure a complete pre-test of your system. Assure you a quicker installation and a faster, trouble-free start-up. Call your nearby Cutler-Hammer office early.

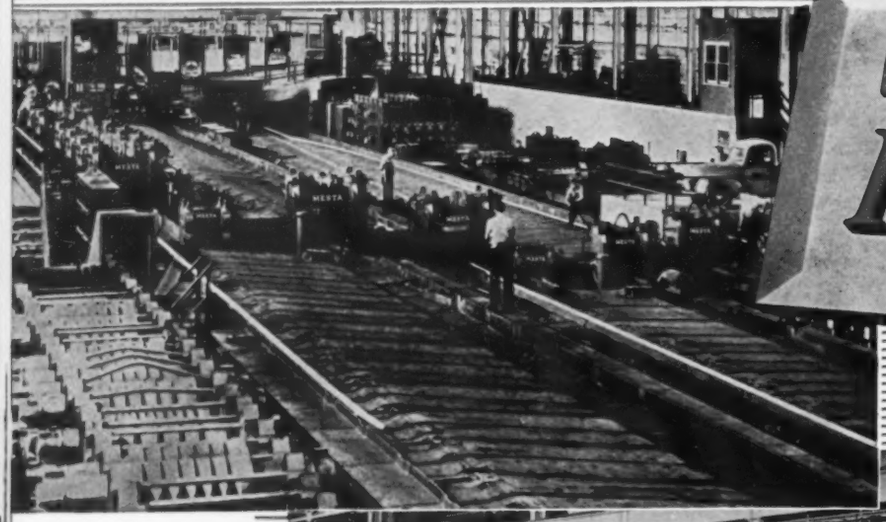
WHAT'S NEW? ***ASK...***

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

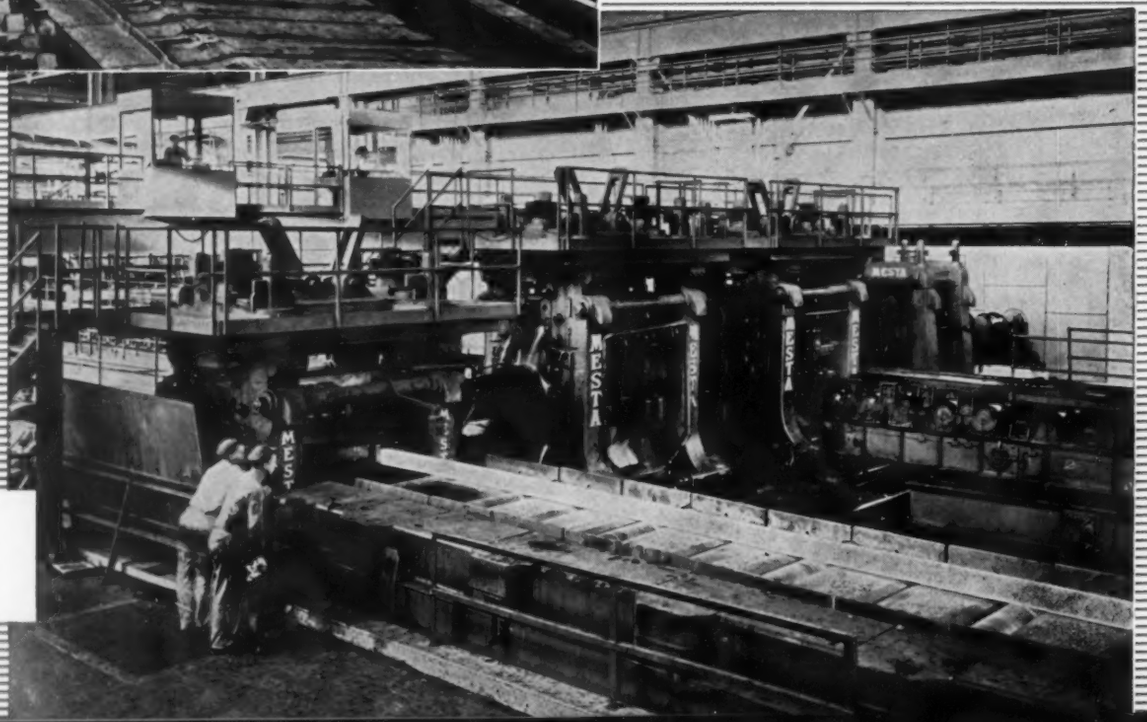


MESTA 148" Four-High Reversing Plate Mill.

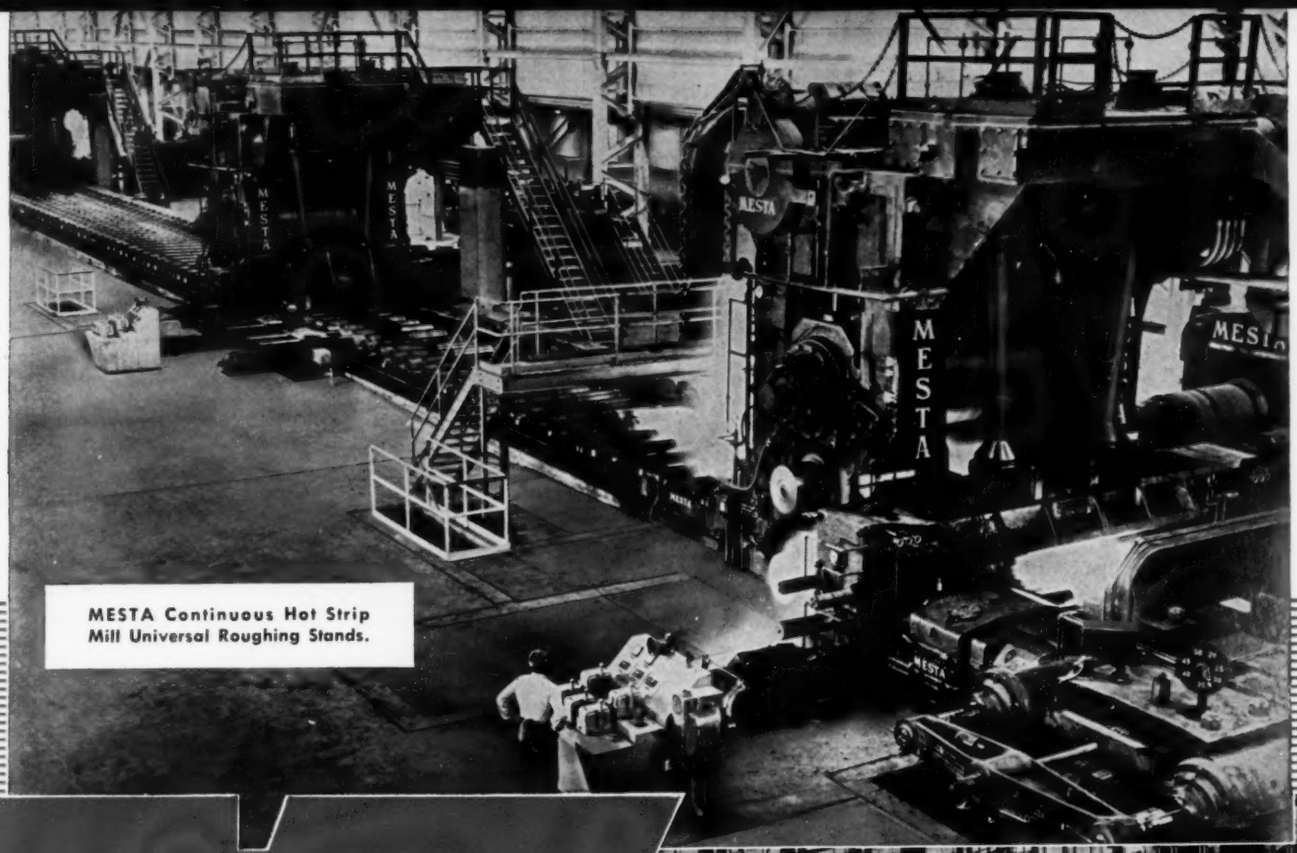


Designed and Built by MESTA

MESTA 18"-14"-10" Merchant Mills With Cooling Bed and Equipment.



MESTA 29" Structural Mill With Traveling Tilting Table.

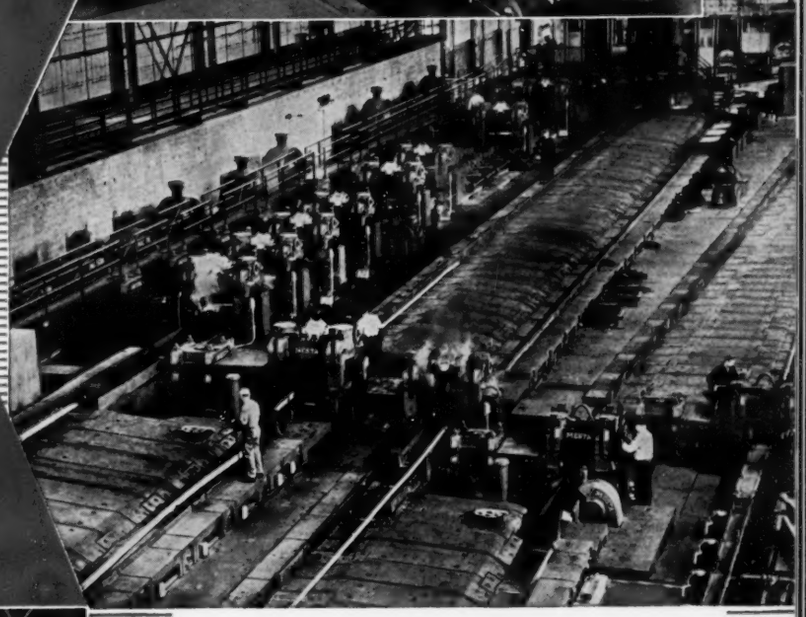


MESTA Continuous Hot Strip Mill Universal Roughing Stands.

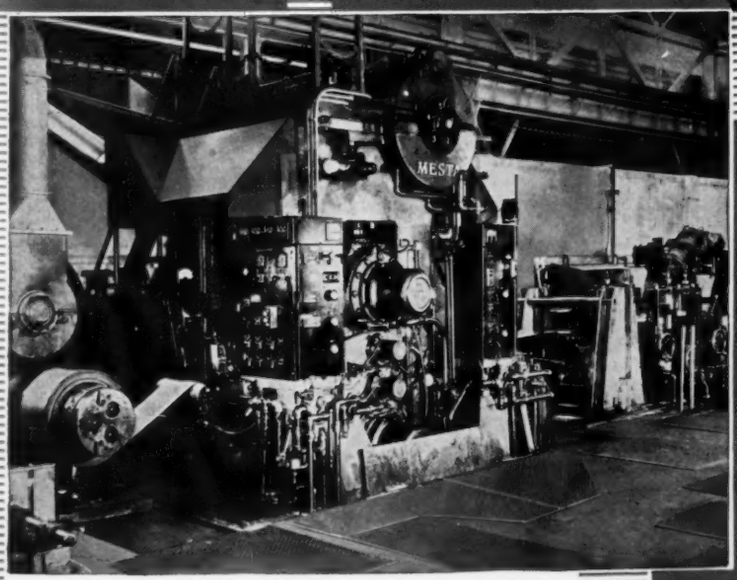
FOR

KAISER STEEL CORPORATION

FONTANA, CALIFORNIA



Rolling Bars and Shapes on a MESTA Merchant Mill.

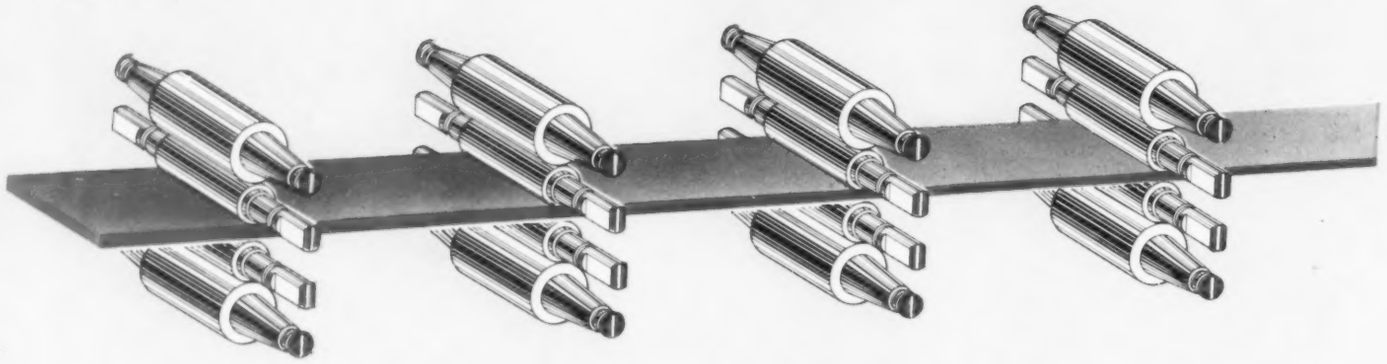


MESTA 24" Four-High Single Stand Reversing Cold Mill.

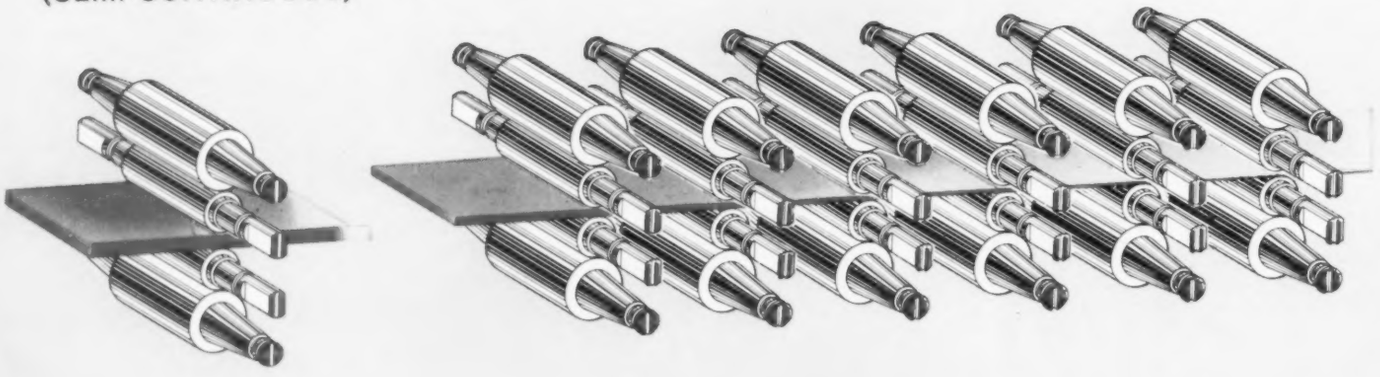
MESTA MACHINE COMPANY

PITTSBURGH
PENNSYLVANIA

(CONTINUOUS)



(SEMI-CONTINUOUS)



Mack-Hemp rolls are right for every mill...

IN HOT STRIP MILLS...

These Mack-Hemp steel and iron rolls have met every test the nation's hot strip mills have put to them. They are:

Technalloy . . . First heavy-duty cast alloy steel roll with high strength. An economical back-up roll for all 4-high stands, and a fine work roll in 2-high roughing stands.

Technikrome . . . A high-carbon alloy steel roll of wide versatility. A good roughing stand work roll under average operating conditions.

Nichillite . . . A definite chill alloy iron utility roll providing high hardness and wear resistance. Recommended for finishing work under good-to-average conditions.

Nironite A and AX . . . Nickel chromium alloy grain iron rolls with high strength and deep hardness penetration.

Nironite F . . . High alloy grain iron roll, double-poured for maximum core and neck strength, and specially heat treated to increase resistance to thermal shock and spalling.

KEY TO MODERN HOT STRIP ROLLING...

	CONTINUOUS		SEMI-CONTINUOUS	FINISHING TRAIN		
	Broadside Mill	Roughing Stands	Reversing Roughing Stand	Stands 1 & 2	Stands 3, 4 & 5	Finishing Stand
WORK ROLLS						
Good Conditions	Nironite AX 68 Shore	Nironite AX 68 Shore	Nironite F 68-72 Shore	Nironite F 74 Shore	Nironite F 78 Shore	#4 Nichillite 80 Shore
Average Conditions	Nironite A 65 Shore	Technikrome 40 Shore	Nironite F 68-72 Shore	Nironite F 74 Shore	Nironite F 78 Shore	#6 Nichillite 80 Shore
Severe Conditions	Technalloy 40-45 Shore	Technalloy 45 Shore	Technalloy 42-48 Shore	Superalloy 48-50 Shore	Nironite F 78 Shore	Nironite F 80 Shore
BACK-UP ROLLS (in 4-HI STANDS)	Technalloy 48 Shore	Technalloy 48 Shore	Technalloy 48 Shore	Technalloy 48 Shore	Technalloy 48 Shore	Technalloy 48 Shore

Midland Superalloy . . . A nickel-chromium-molybdenum alloy steel roll especially developed to withstand fire cracking and breakage under severe operating conditions.

• • •

In short, there is a Mack-Hemp roll that is just right for each stand and each set of operating conditions. This tailoring of the rolls to the mill is one of the important reasons why *you get more tonnage from the rolls with the striped red wabblers.*

MACKINTOSH-HEMPHILL

DIVISION OF

E. W. BLISS COMPANY

Pittsburgh and Midland, Pa.

MACKINTOSH-HEMPHILL DIVISION PITTSBURGH U.S.A.

BLISS

Mackintosh-Hemphill Division of E. W. Bliss Co. is proud to be numbered among the suppliers of Kaiser Steel Corp.'s Fontana Works.

World's largest electrical precipitators for basic oxygen steelmaking

The Cottrell precipitators at the right of the photo remove dust and fume from waste gases at the Kaiser Fontana Plant with 99.8% efficiency. This huge new basic oxygen steel plant was designed and constructed by Kaiser Engineers.

The three Cottrells were designed and built by Research-Cottrell to clean 607,500 cubic feet of gas per minute from the oxygen furnaces. They are installed between the furnace exhaust ducts and the fans serving the three stacks seen at right below.

The high gas cleaning efficiency of this installation is obtained by means of tested and proven Cottrell design features including electrical sectionalization, Opzel collecting plates, and continuous, automatic operation of high tension rappers and M.I. plate rappers.

Research-Cottrell provides the most modern and comprehensive engineering and equipment available, based on hundreds of Cottrell installations all over the world.

For further information call on...

Research-Cottrell

RESEARCH-COTTRELL, INC., Main Office and Plant: Bound Brook, N. J.
Representatives in principal cities of U.S. and Canada

RC-210

BLAW-KNOX

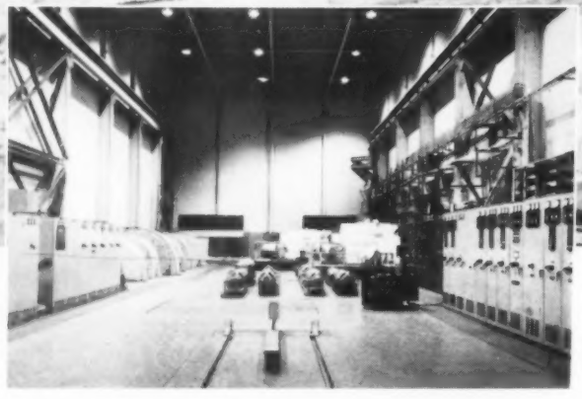
Universal Slabbing Mills

Blaw-Knox designs and builds slabbing-blooming mills in a complete range of sizes in universal and high lift types. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and nonferrous metals, sheet and strip processing equipment, electrolytic tinning, annealing, and galvanizing lines, seamless pipe and tube mills, draw benches, and cold draw equipment, Blaw-Knox Medart cold finishing equipment, iron, alloy iron and steel rolls, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings. Blaw-Knox Company, Foundry and Mill Machinery Division, Blaw-Knox Building, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.

46 x 90 inch Universal Slabbing Mill.

Clean Air by AAF at Kaiser's Fontana Works

FONTANA WORKS, KAISER STEEL CORPORATION



Spotless motor room typifies Kaiser's clean-air planning

The motor room for the cold reduction stand in the tin mill is a perfect example of the clean-air planning that went into Kaiser's Fontana Works. One type of AAF filter is on the job here – making sure the motor room perpetually stays just as clean as it is right now.

Four other types of AAF filters are at work elsewhere in the Kaiser plant. For every individual clean-air need there is *one* filter that offers optimum correlation of filter cost, efficiency and maintenance. To *find* that one filter, talk with the people at AAF —the *one* company that makes *all kinds.*

For a look at a really complete line of filters, call your local AAF representative or write us direct for Bulletin 518. Address: Mr. Robert Moore, American Air Filter Company, Inc., 302 Central Avenue, Louisville, Kentucky.

AAF American Air Filter

BETTER AIR IS OUR BUSINESS

AFI MEMBER

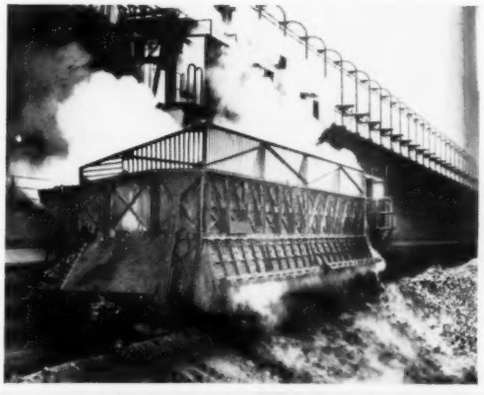
Atlas Serving

KAISER STEEL

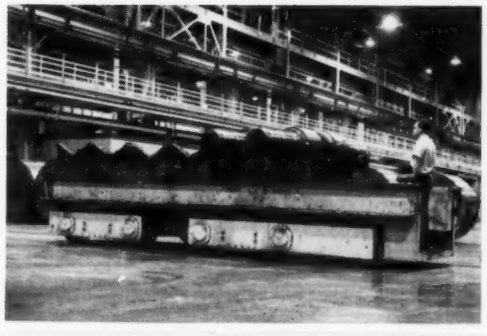
Fontana Works

One of the 40-Ton Double Compartment Scale Cars used by Kaiser at Fontana.

Kaiser, like most of the prominent steel producers, uses Atlas Scale Cars for blast furnace stockhouse service. As with other Atlas steel plant equipment, these cars are highly regarded because they are dependable, accurate, and require little maintenance.



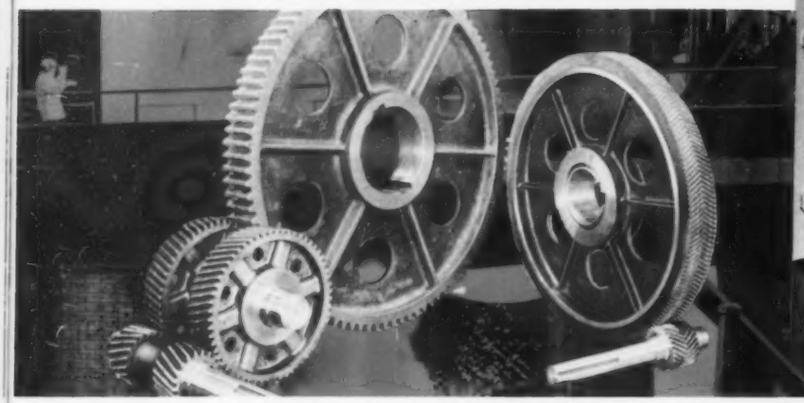
Coke Quenching Car.



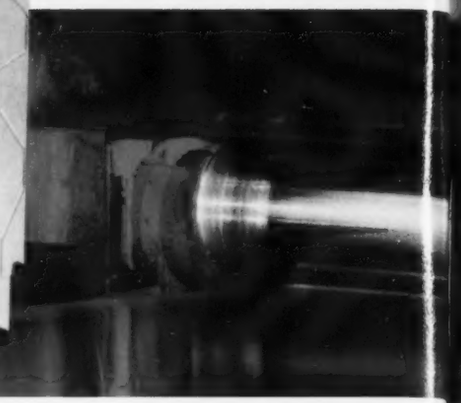
Safety-type Battery Operated Roll Transfer Car.

ATLAS CAR & MFG. CO.

1100 IVANHOE ROAD, CLEVELAND 10, OHIO



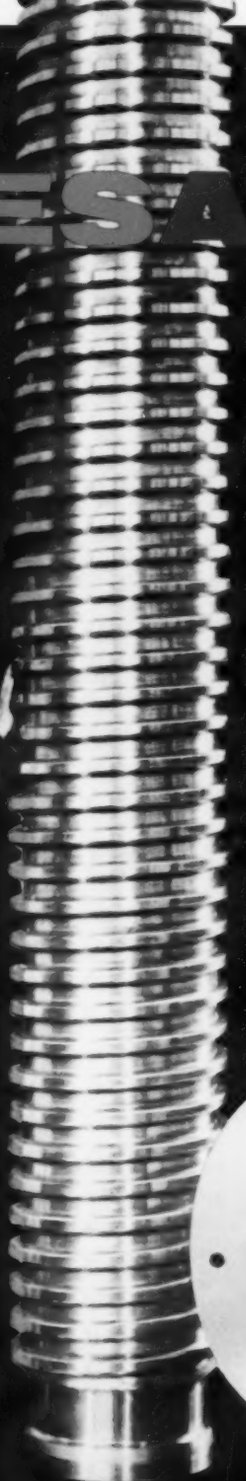
Basic oxygen steelmaking plant has cranes equipped with TSP gearing.



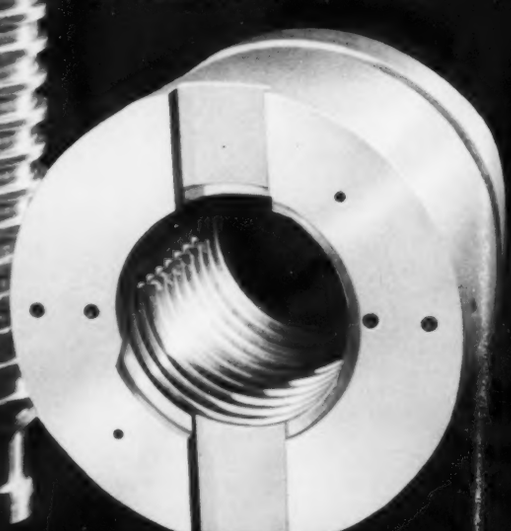
TSP 9½" work rolls (new and rehardened) on 2-high, 4-high twin temper mills.

TSP

TSP GOES AHEAD V

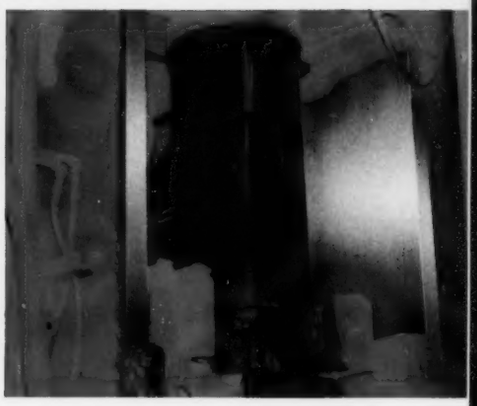


TSP screw and screwdown nut used on 46" blooming mill.



TSP gear and wheel on 50 ton gantry crane.

TSP track wheels used throughout the plant.



TSP window liners on 46" blooming mill.

WITH KAISER STEEL

"Tool Steel Process" hardened products are used on equipment in all divisions of the Kaiser Steel Corporation plant at Fontana, California.

TSP hardened products have been used for years because their phenomenally long wear qualities enable equipment to keep running longer, more accurately and more economically. TSP products are hardened by our special process. A Lo-Ha surface to the full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. These departments of Kaiser Steel use TSP products:

TIN MILL ... uses 9½" and 28½" work rolls on two temper mills. TSP 22" rolls are used on the 4-stand tandem mill. Also, window liners, table gearing, leveller straightener and pinch rolls, all types of gearing, screws and nuts.

OPEN HEARTH ... uses gears, pinions, wheels, rope drums for ladle and pit cranes. Gears, pinions and wheels on charging machines.

SLABBING MILL ... uses screwdown screws and nuts, window liners, table gearing.

86" HOT STRIP MILL ... uses screwdown screws, gearing, table gearing, window liners, rolls.

143" PLATE MILL ... uses table gearing, window liners, rolls.

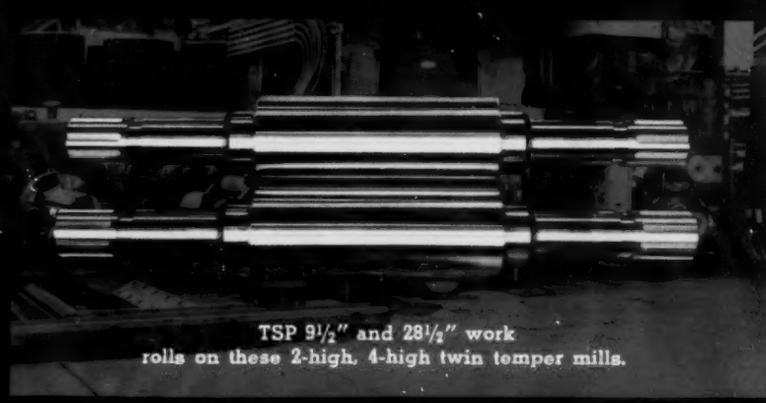
C-W PIPE MILL ... uses pinion rolls.

... keep your equipment running longer ... write today for information ... Steel Industry.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO

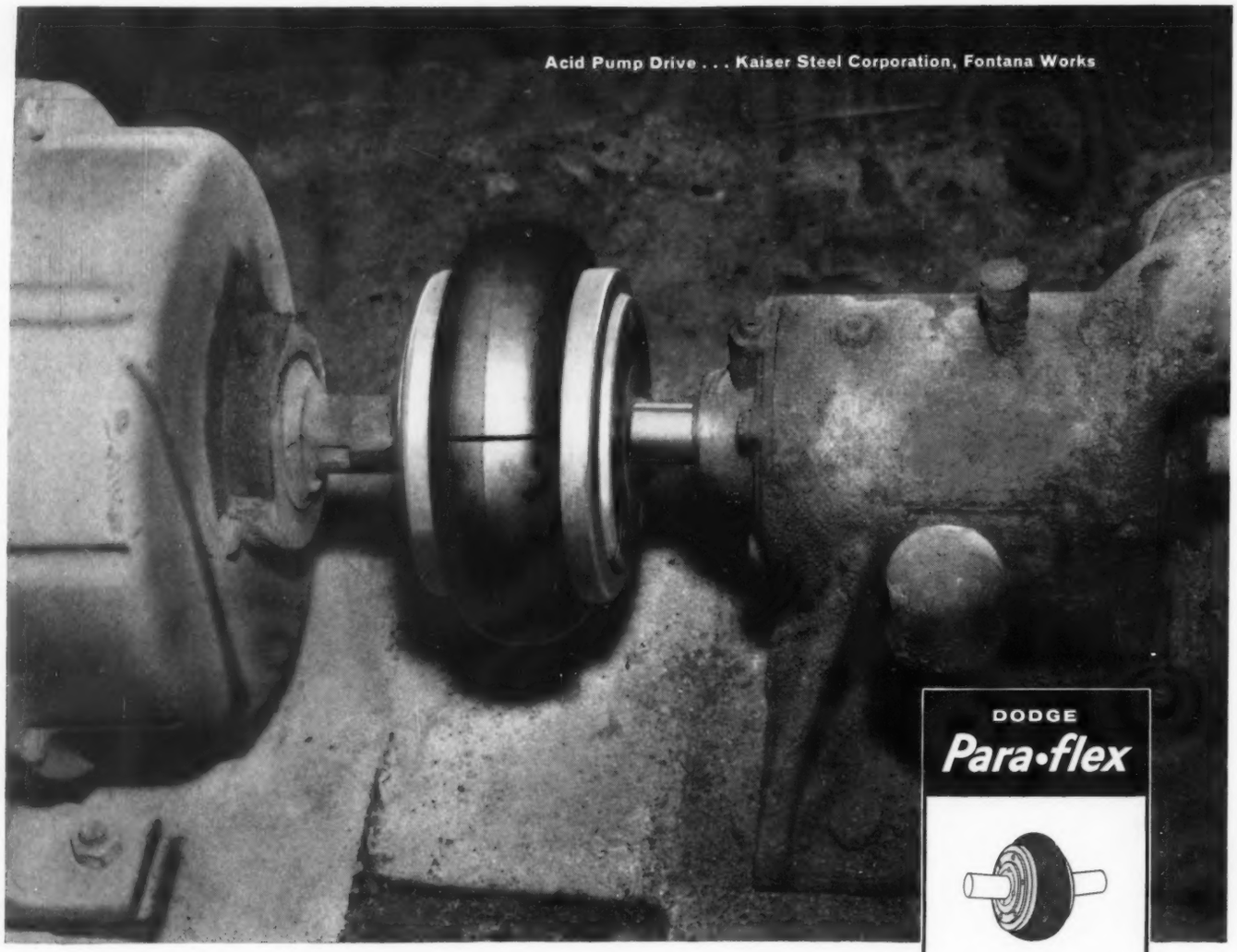
AD 1050
Printed in U.S.A.

TSP line shafts and drive gearing used on tables.



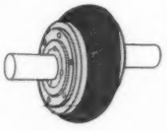
TSP 9½" and 28½" work rolls on these 2-high, 4-high twin temper mills.

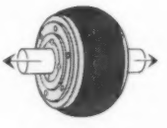
PINIONS, ROLLS, WHEELS AND OTHER HARDENED PRODUCTS

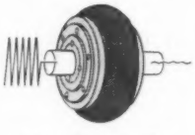


DODGE
Para•flex

Takes
Angular Misalignment


Takes
Parallel Misalignment


Takes
End Float


Absorbs Vibration

Years of heat and acid

Tough operating conditions are taken in stride by Dodge Para-flex. These flexible cushion couplings can stand most anything. After years of exposure to acid fumes, heat and ozone on this acid pump, the tire-like flexing element of the Para-flex still does its job.

Dodge Para-flex flexible cushion couplings "swallow up" angular and parallel misalignments, end float (or any combination), absorb vibrations and cushion shock loads.

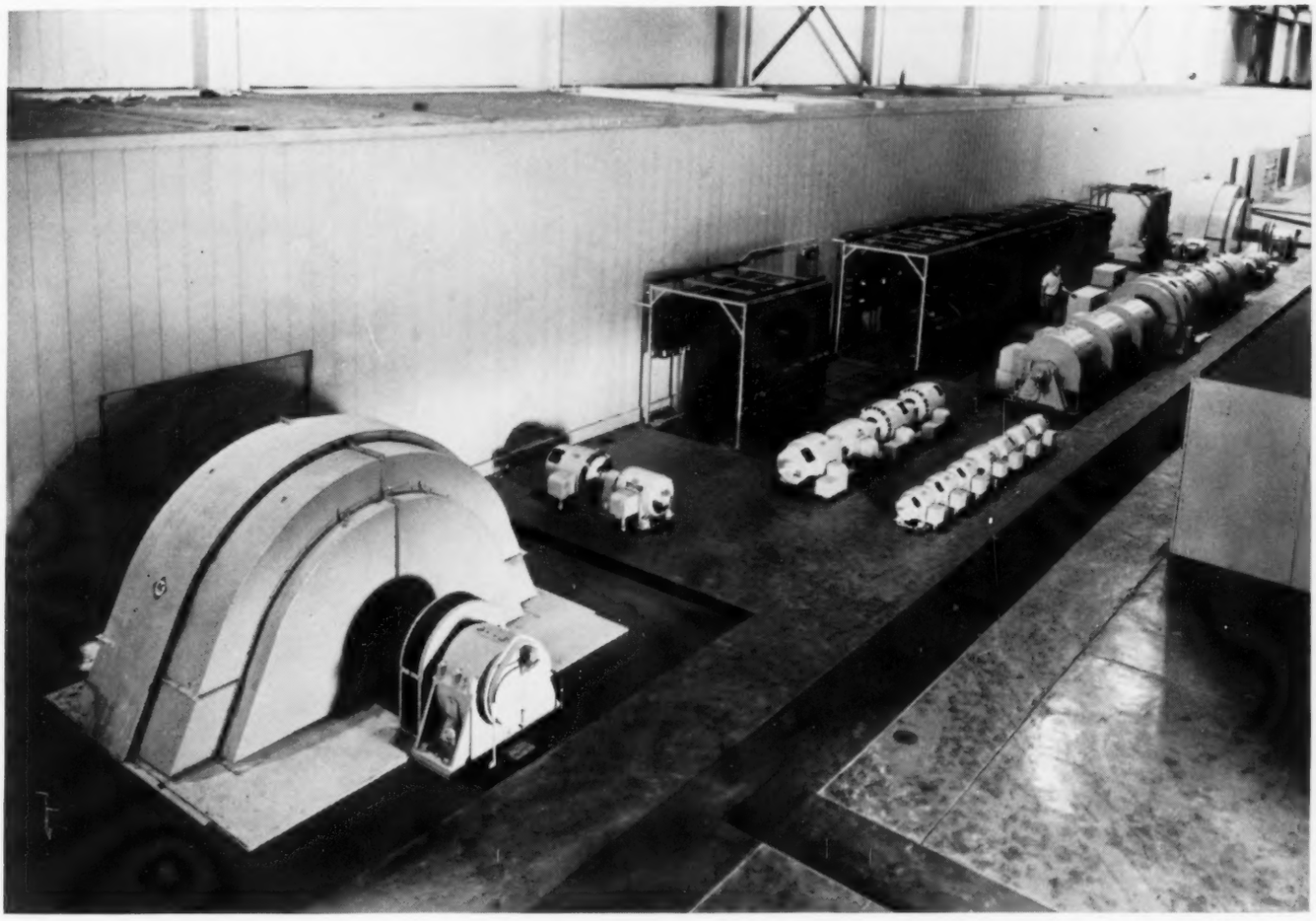
The Standard Type is made in capacities up to 3640 hp at 910 rpm. High Speed and Flywheel Types up to 5230 rpm. Ask your Dodge Distributor—or write us for new technical bulletin on Para-flex, the "coupling with the 4-way flex."

Dodge Manufacturing Corporation, 5900 Union St., Mishawaka, Ind.

The Products with the Pluses... **DODGE** *of Mishawaka, Ind.*

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory-trained by Dodge he can give you valuable assistance on new cost-saving methods.

ALLIS-CHALMERS



Power for Kaiser Steel

Allis-Chalmers powers hot strip roughing train at Fontana

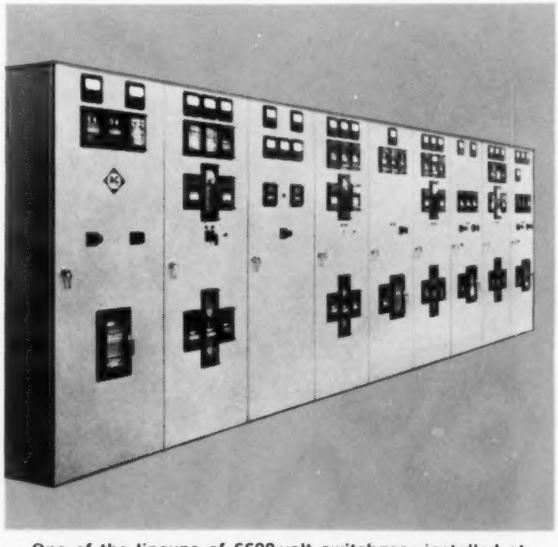
Steel companies look to Allis-Chalmers for leadership in powering hot strip mills. Reason? *Experience.* During the past 10 years, A-C has upgraded numerous finishing trains and has powered most of the roughing trains installed in this country.

Allis-Chalmers roughing train equipment at Fontana includes 6600-volt switchgear, four 6000-hp synchronous motors, one 5000-hp wound-rotor motor and one 3000-hp synchronous motor. Variable voltage control for edgers and slab squeezers was also provided, along with supporting variable voltage motor-generator sets, and dynamic braking and inching equipment.

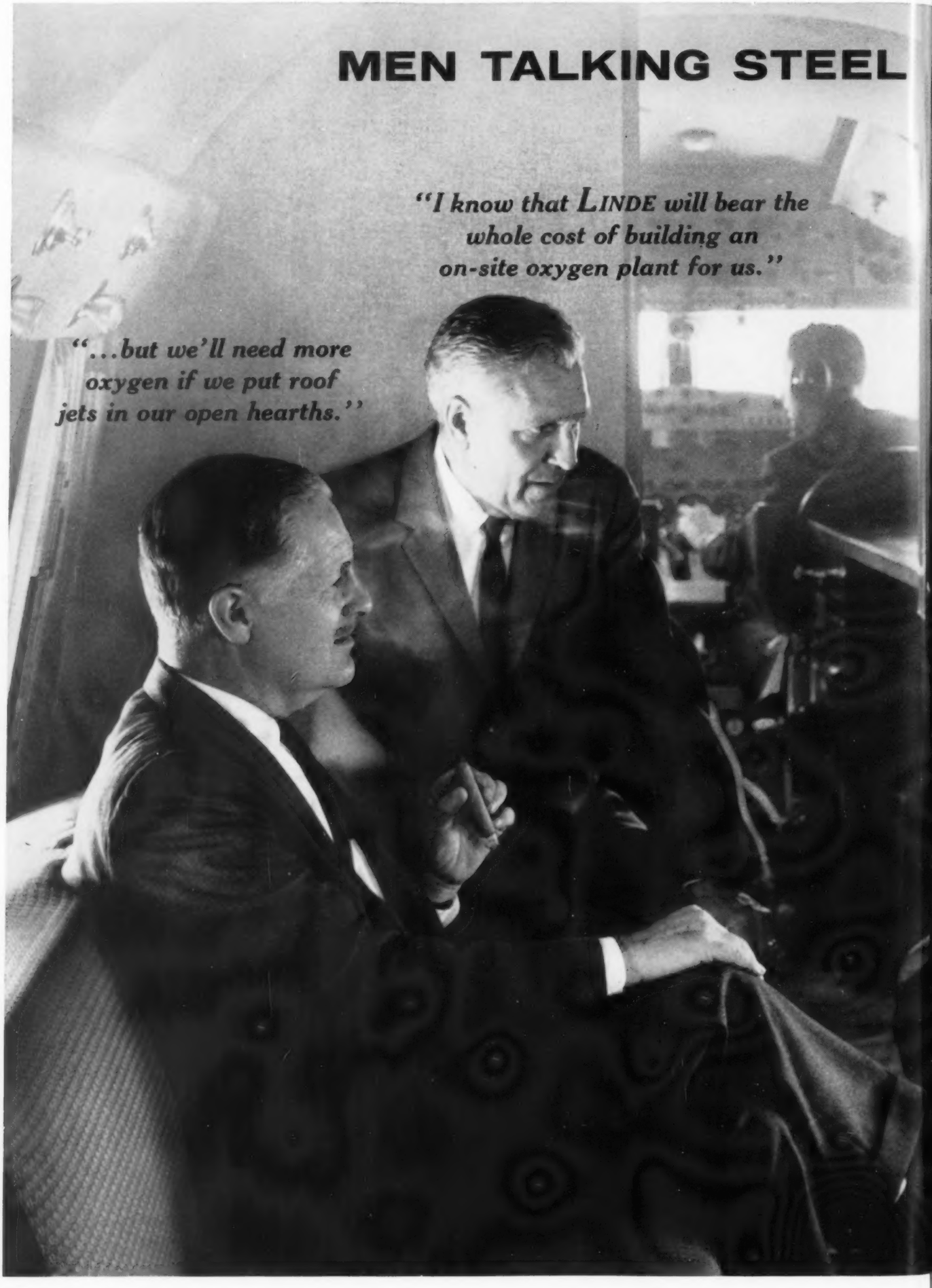
In addition to equipment for steel mills — motors, control, switchgear, transformers, rectifiers, compressors, steam turbines, pumps — Allis-Chalmers will undertake responsibility for designing complete operating facilities. This *Systemation* service is based on processing knowledge gained as a major supplier of power equipment plus electronic control system experience gained through Consolidated Systems Corporation, an affiliate company.

For information on Allis-Chalmers power*full leadership, contact your A-C representative or write,* **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1418

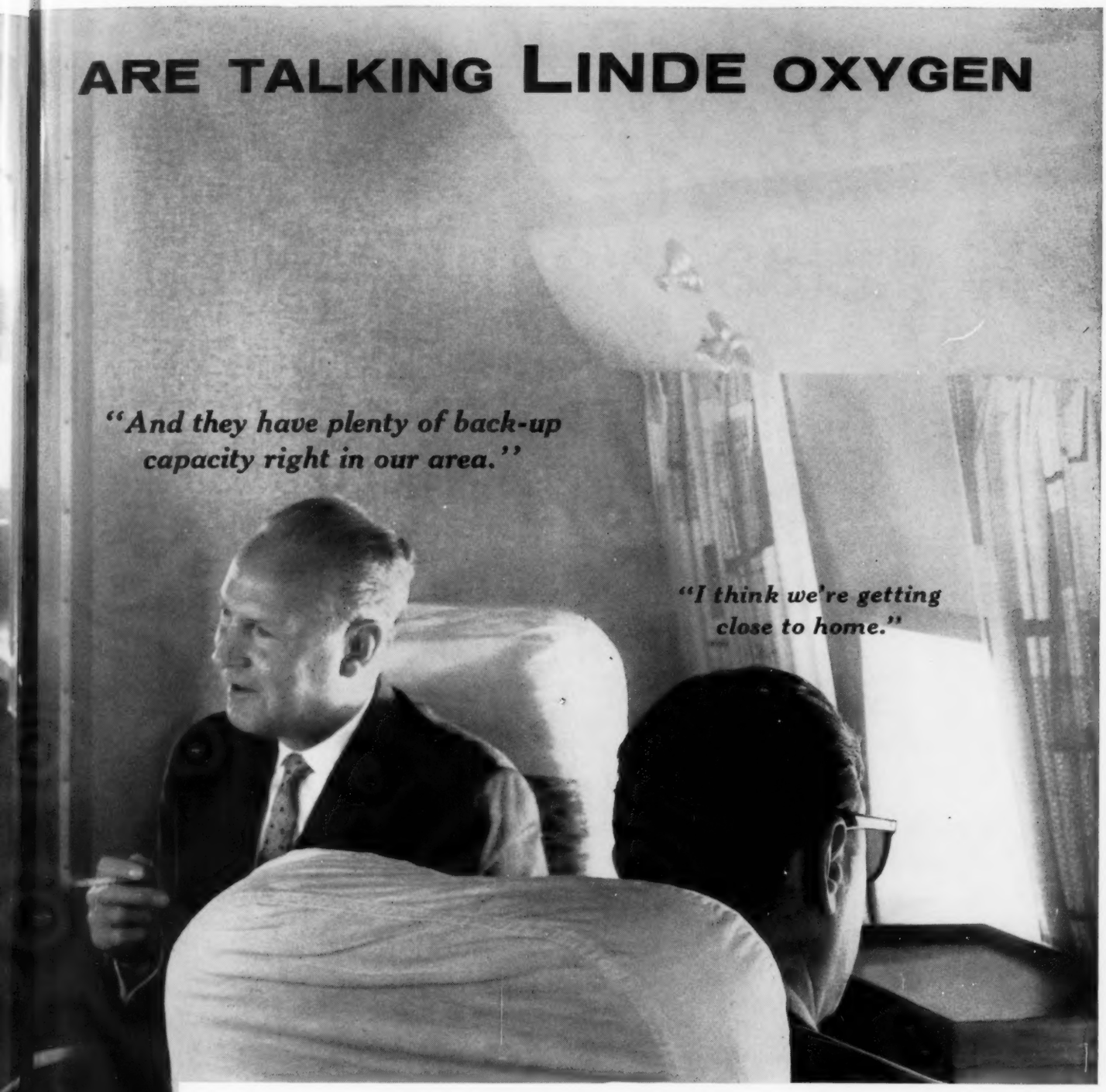
Systemation is an Allis-Chalmers servicemark.



One of the lineups of 6600-volt switchgear installed at Kaiser's Fontana Works.


MEN TALKING STEEL
"I know that LINDE will bear the whole cost of building an on-site oxygen plant for us."
"...but we'll need more oxygen if we put roof jets in our open hearths."

ARE TALKING LINDE OXYGEN



You can learn what LINDE's *total gas technology* means to on-site plants for steelmakers by writing Linde Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada,* Union Carbide Canada Limited, Linde Gases Division, Toronto 12.

LINDE COMPANY

UNION CARBIDE

"Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation

Chemico P-A Venturi Gas Washer Chosen By Kaiser For No. 1 Blast Furnace

The venturi washer at the Kaiser plant is just one of fifty CHEMICO venturi washers specified and installed by major steel producers for cleaning blast furnace gas. Performance figures and maintenance records of blast furnaces using CHEMICO venturi washers indicate the following:

1 The CHEMICO venturi washer is the most efficient wet washer in operation anywhere. Where higher top pressures are available, for example, gas can be cleaned to less than 0.003 Gr/Scf, eliminating the need for secondary precipitators.

2 CHEMICO venturi washers require virtually no maintenance for an entire furnace campaign.

3 Capital and installation costs are less than other primary or secondary gas cleaners.

4 Minimum space is required. Generally, the CHEMICO venturi washer is set into space formerly occupied by gas mains.

5 Water requirements are about a third of other wet washers.

6 Latest designs incorporate adjustable controls which enable maximum gas cleaning efficiency to be maintained regardless of wind rate.

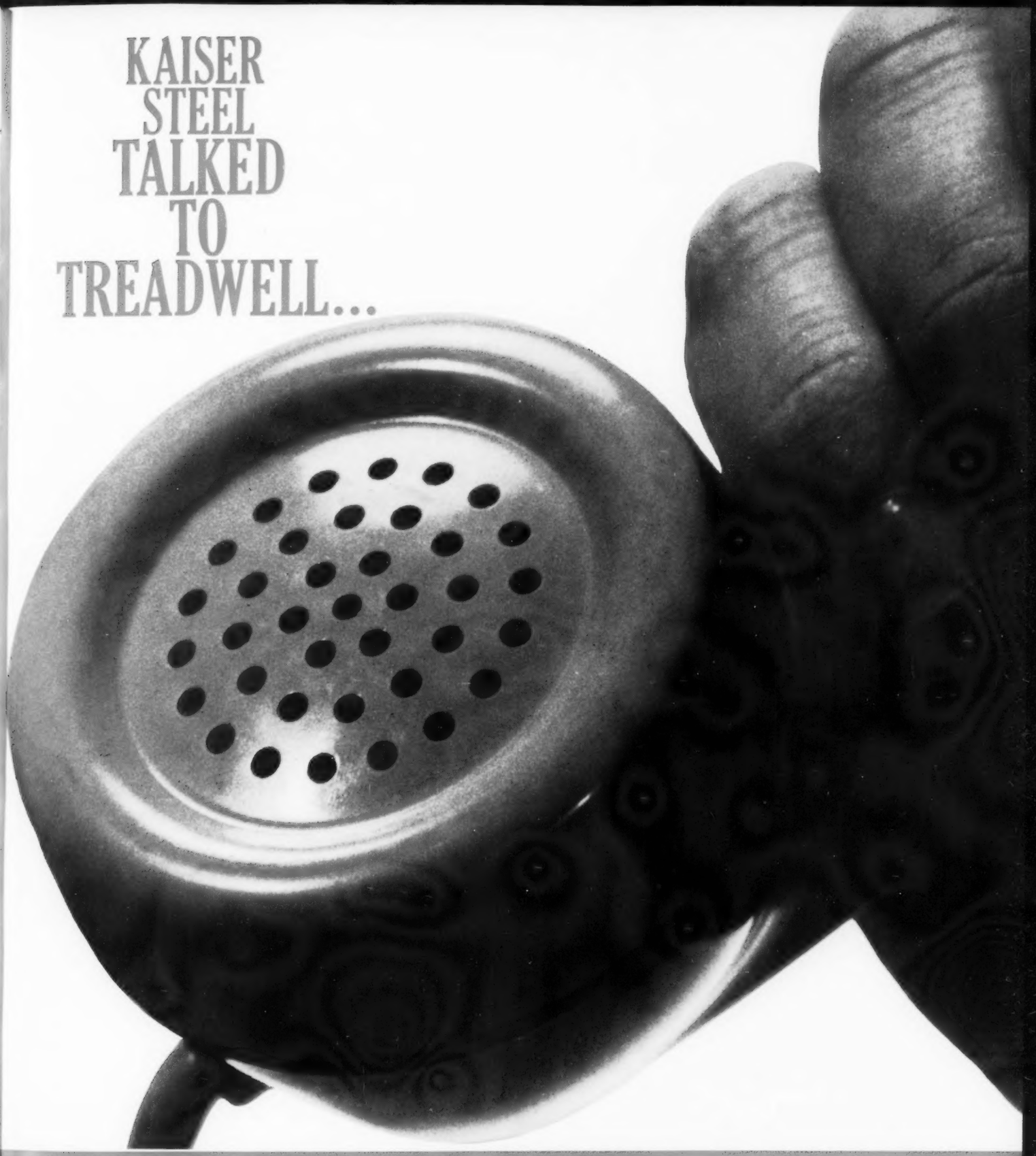
If you are considering the installation of gas cleaning equipment on a blast furnace, a CHEMICO representative would be pleased to show you the kind of top-performance job you can expect from a Venturi washer. CHEMICO handles the complete job, **Planning, Design, Engineering, Erection and Start-up.**

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
GAS SCRUBBER DIVISION
320 Park Avenue, New York 20, New York

Sales Representatives in:
Ferndale, Mich. • Chicago, Ill. • Los Angeles, Calif. • Houston, Tex. • Bartow, Fla. • Birmingham, Ala. • Millersville, Pa.

KAISER STEEL TALKED TO TREADWELL...



. . . about mixer-type, hot metal cars for the extensive Kaiser Fontana Works. Since the opening of the Works in 1943, TREADWELL has engineered and manufactured all of the mixer cars required at the installation. Advanced TREADWELL engineering is evident in the changes from the first cars delivered to the recent models, as TREADWELL designed the cars to fit the specifications. TALKING TO TREADWELL pays dividends in better planning and more efficient transportation equipment.

M. H. TREADWELL COMPANY, INC.
140 CEDAR ST. NEW YORK 6, N. Y. ■ WOrth 4-3344
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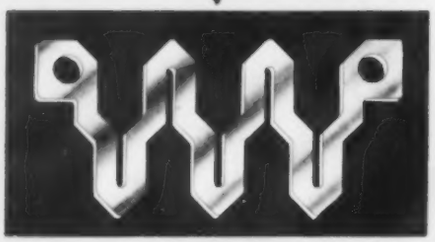
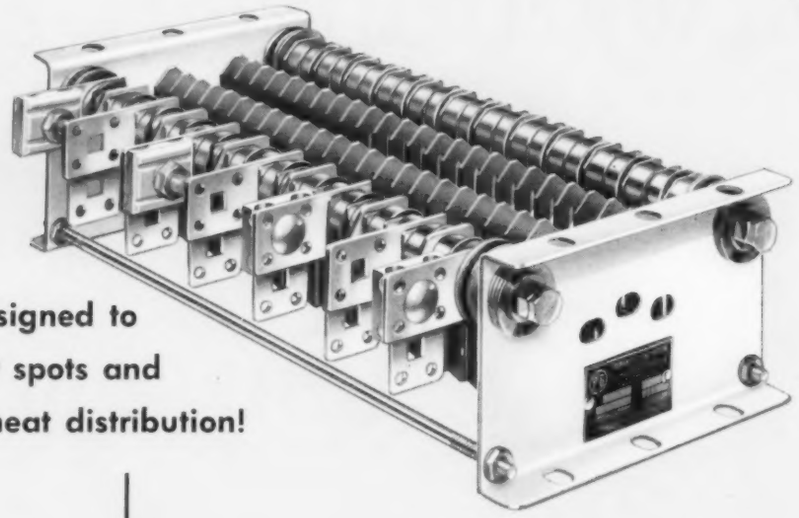
1015 Farmers Bank Building, Pittsburgh 22, Pa.
208 South La Salle Street, Chicago 4, Illinois
SALES REPRESENTATIVES:
Shook & Fletcher Supply Company
1814 First Avenue North, Birmingham, Alabama
R. A. Ashby, 7 Live Oak Way, Kentfield, Calif.

TREADWELL
MIXER CARS

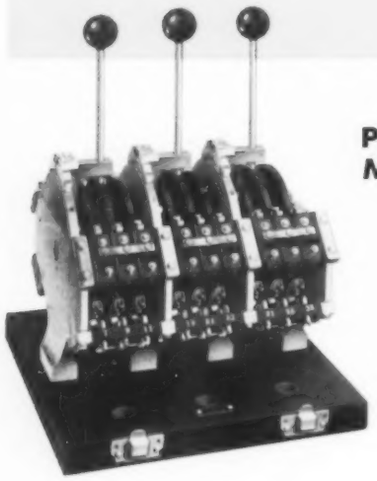
ONE OF KAISER STEEL'S 23 150-TON TREADWELL MIXER-TYPE HOT METAL CARS

Ventilation *is the HEART of any Resistor...*





P-G GRID . . . designed to eliminate hot spots and insure even heat distribution!



P-G *Improved* **Master Switch**

Lighter in weight
Easier to wire

Type MD for general application in Mill Service

Each single Master has a maximum of 12 circuits and up to 6 points either direction. One to four switches in a single enclosure saves valuable mounting space. Overall length less than 22" on four unit switch. Short lever travel. Self-lubricating bearings. Fine silver double break contacts. Spring return (optional). Enclosure easily removed.

Write for Bulletin No. 410

Longer resistor life depends on adequate ventilation and how efficiently heat is dissipated. P-G grid design equalizes the amount of air space surrounding each leg or loop to obtain even heat thruout the grid area . . . note illustration.

Compare P-G with any other punched steel grid resistor — you will find more air space is provided. This produces better ventilation — longer resistor life and over twenty-five years of use in steel mill service has proven this.

For the maximum in resistor value, try P-G the ORIGINAL Steel Grid Resistor.

Write for Bulletin No. 500

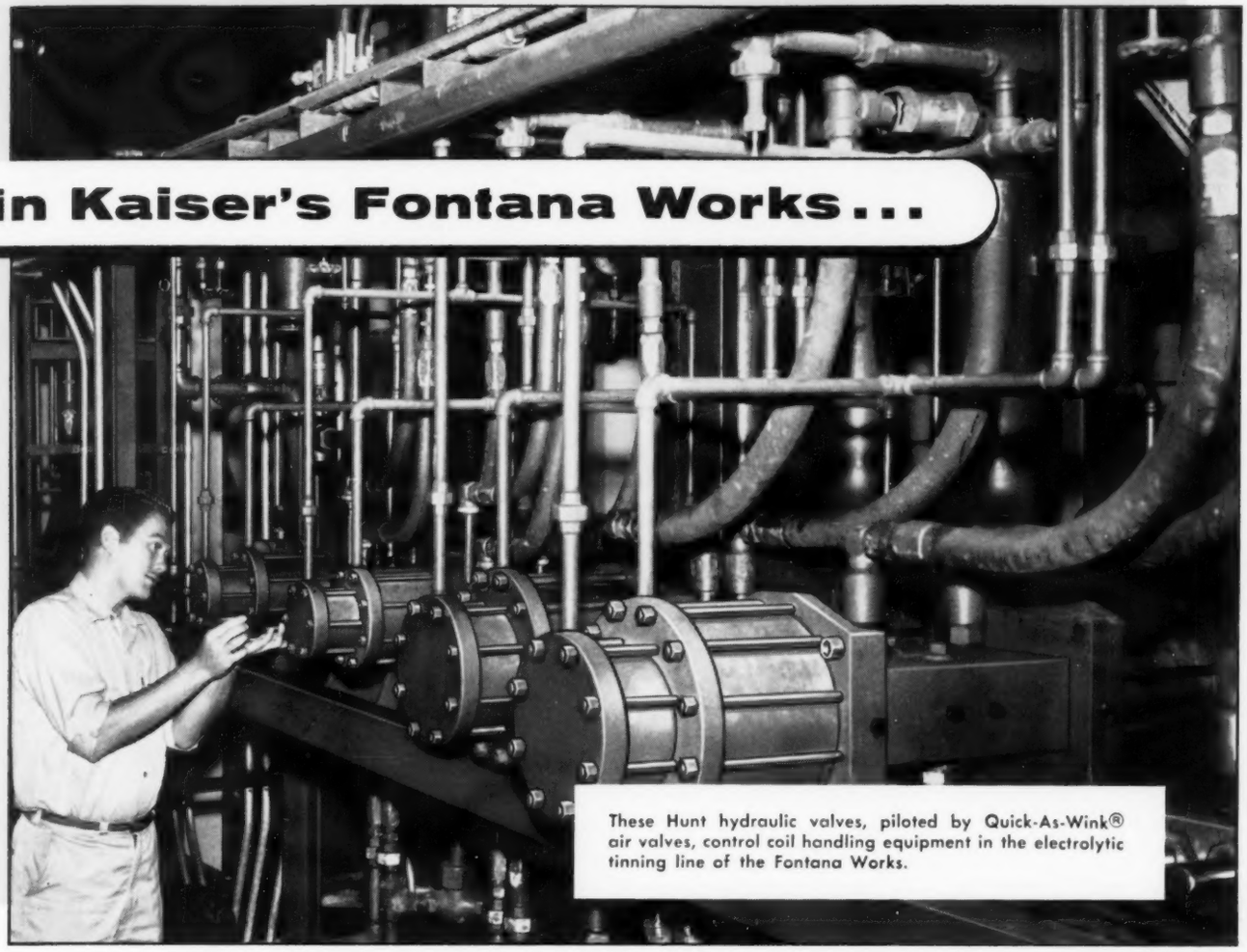
- **These P-G products are used in the Fontana Works of Kaiser Steel.**

Established 1892

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky

MAILING ADDRESS—Box 709, Covington, Kentucky



in Kaiser's Fontana Works...

These Hunt hydraulic valves, piloted by Quick-As-Wink® air valves, control coil handling equipment in the electrolytic tinning line of the Fontana Works.

HUNT VALVES

deliver precise control... dependable performance

Used at key points throughout Kaiser's Fontana Works, Hunt air and hydraulic valves provide the precise, dependable control necessary to assure efficient production of high quality steel.

Hunt Valves are widely used in the plant . . . in the descaling systems as accumulator shut-offs and line descaling valves . . . to control coil handling equipment . . . and to control a variety of associated hydraulic systems, both oil and water soluble oil types. Three of the accumulator systems in the Fontana Works are controlled completely by Hunt Accumulator Control Panels.

The Hunt line includes valves in sizes ranging from ⅛ through 8 in. for vacuum to 300 psi air and for water, water soluble oil or oil to 5000 psi.

It'll pay you to find out why leading steel producers consistently choose Hunt valves. Your nearby Hunt representative can give you the facts. Call him today.

For more information, write for Bulletin 603. Address Dept. ISE-261, Hunt Valve Company, Salem, Ohio.

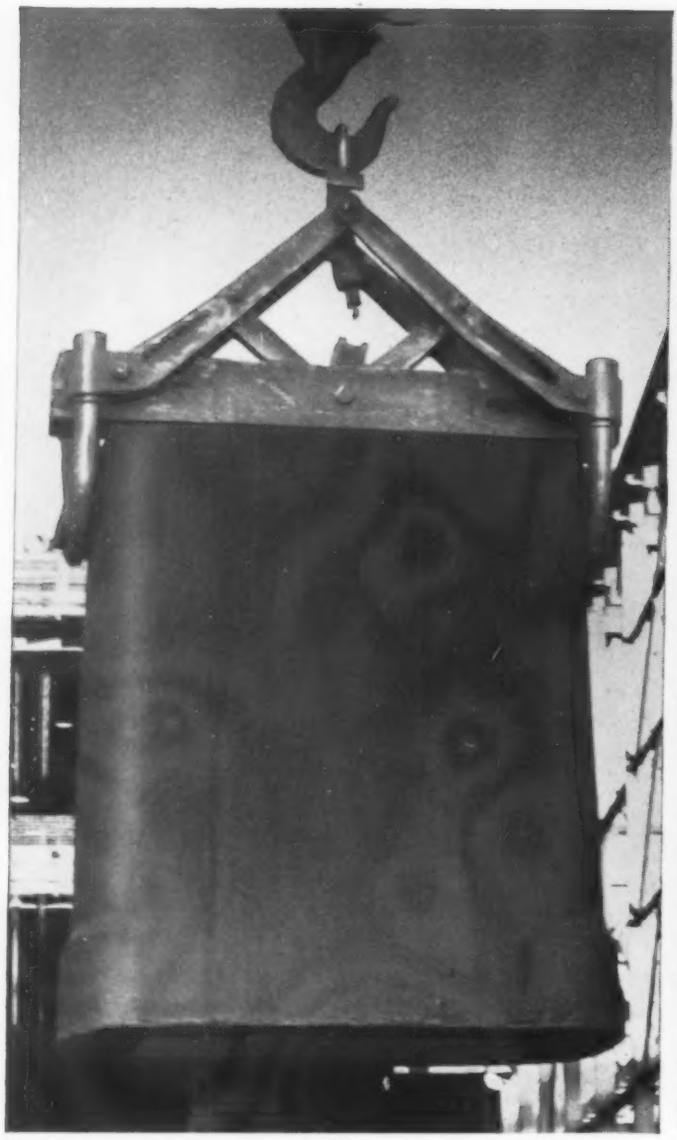
HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

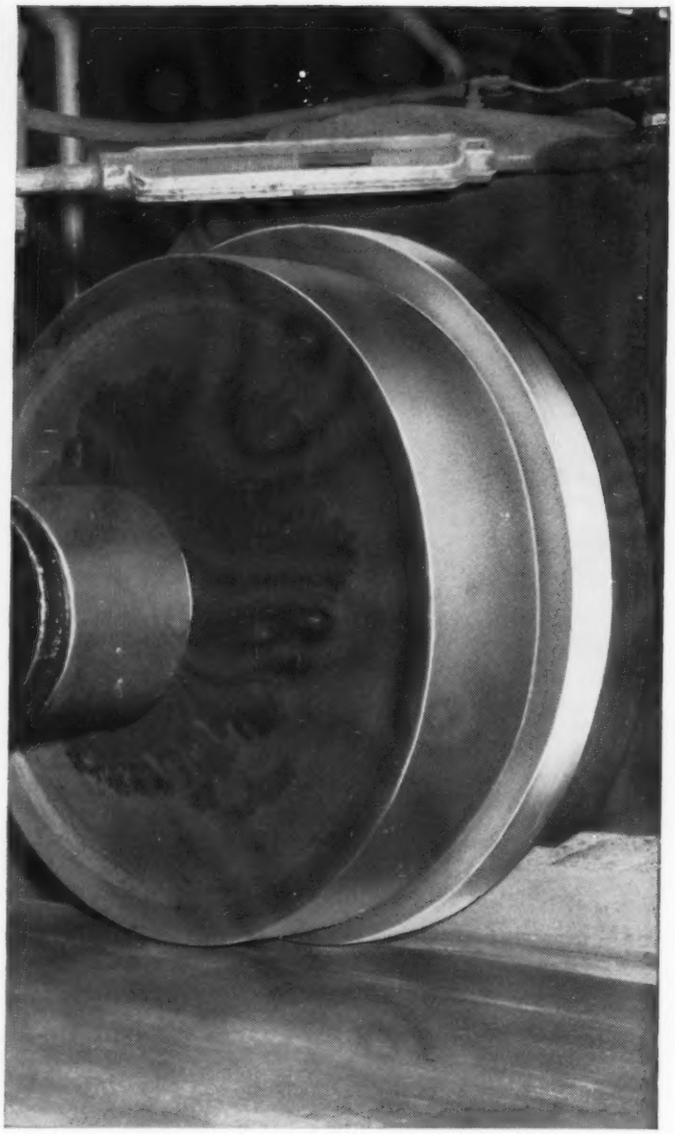
VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

3009



Heppenstall 42,000 pound capacity Ingot Mold Tong lifting empty mold



Heppenstall Side Trimmer Knives trimming plate

from open hearth to finished product

Heppenstall tongs and knives play an important part in steel production at KAISER STEEL CORPORATION, Fontana, California. For more information about Heppenstall products used throughout the steel industry, call your Heppenstall Representative, or write us direct.

HEPPENSTALL COMPANY • PITTSBURGH 1, PA.
Plants: Pittsburgh & New Brighton, Pa. • Bridgeport, Conn.

MIDVALE-HEPPENSTALL COMPANY
NICETOWN, PHILADELPHIA 40, PA.

Die Blocks • Forgings • Back-Up Roll Sleeves • Rings • Industrial Knives
Materials Handling Equipment • Pressure Vessels • Hardened and Ground Steel Rolls • Vacuum and Consumable Electrode Melted Steels

Amsler Morton **40** *Soaking Pit Installation at Kaiser Steel*

$LOWER COST PER TON

■ Key factors resulting in improved productivity and lower cost per ton are: ■ Lower fuel consumption ■ Adaptable to many types of fuels ■ Uniformity of heat ■ Controlled atmosphere ■ Rugged construction—lower maintenance costs

"Engineering consultation in your plant on request"

ENGINEERS AND CONTRACTORS

AMSLER MORTON CO.

MANOR BUILDING • PITTSBURGH 19, PA.

division of TEXTRON INC.

In Canada: AMCO Furnace Contractors Ltd., Toronto, Ontario

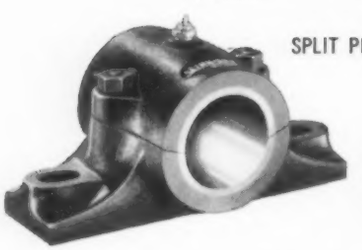
LINK-BELT'S babbitted and bronze bearing line offers

all these designs

all these features

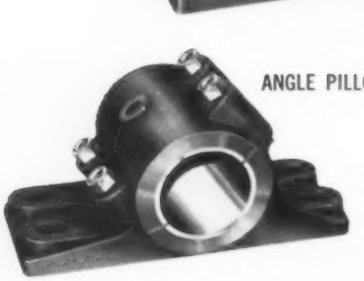
SOLID PILLOW BLOCKS

SPLIT PILLOW BLOCKS

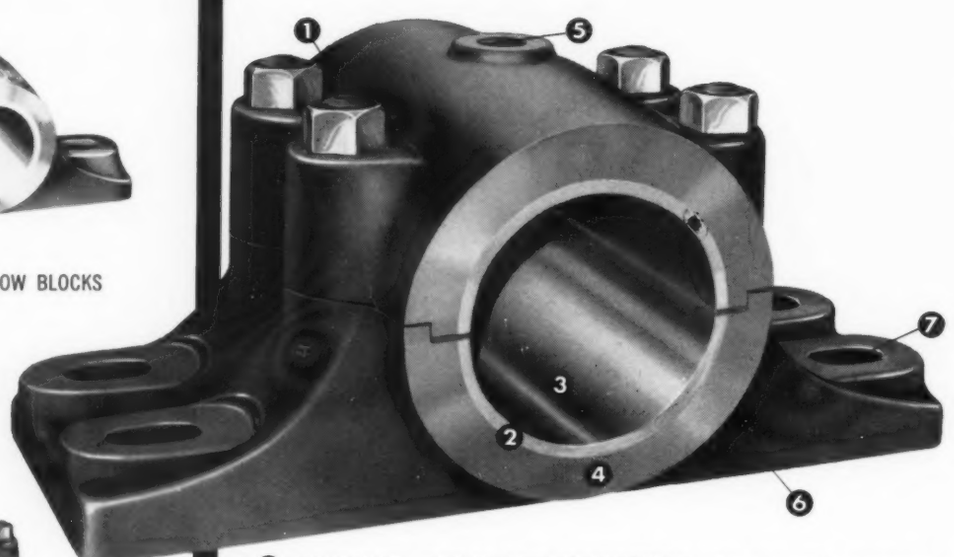


GIBBED PILLOW BLOCKS

ANGLE PILLOW BLOCKS



FLANGED BLOCKS



❶ *RUGGED, COMPACT HOUSINGS of cast gray iron or cast steel,* solid or split design, provide exceptional strength where needed, without excess size or weight. ❷ *STURDY BEARINGS* of thick, heavy-duty babbitt or high-quality bronze are anchored in housing. ❸ *PRECISION MACHINED BORES* provide correct running clearance between shaft and bearing metal for load carrying oil or grease film. ❹ *MACHINE FINISHED ENDS* allow flush mounting of sprockets, pulleys, wheels and collars. ❺ *RELIABLE LUBRICATION*—Holes for grease cups or pressure fittings are drilled and tapped. Grooves distribute lubricant over entire bearing surface. ❻ *MACHINED BASES* assure firm seating on supports. ❼ *SLOTTED BOLT HOLES* permit easy adjustment for shaft alignment.

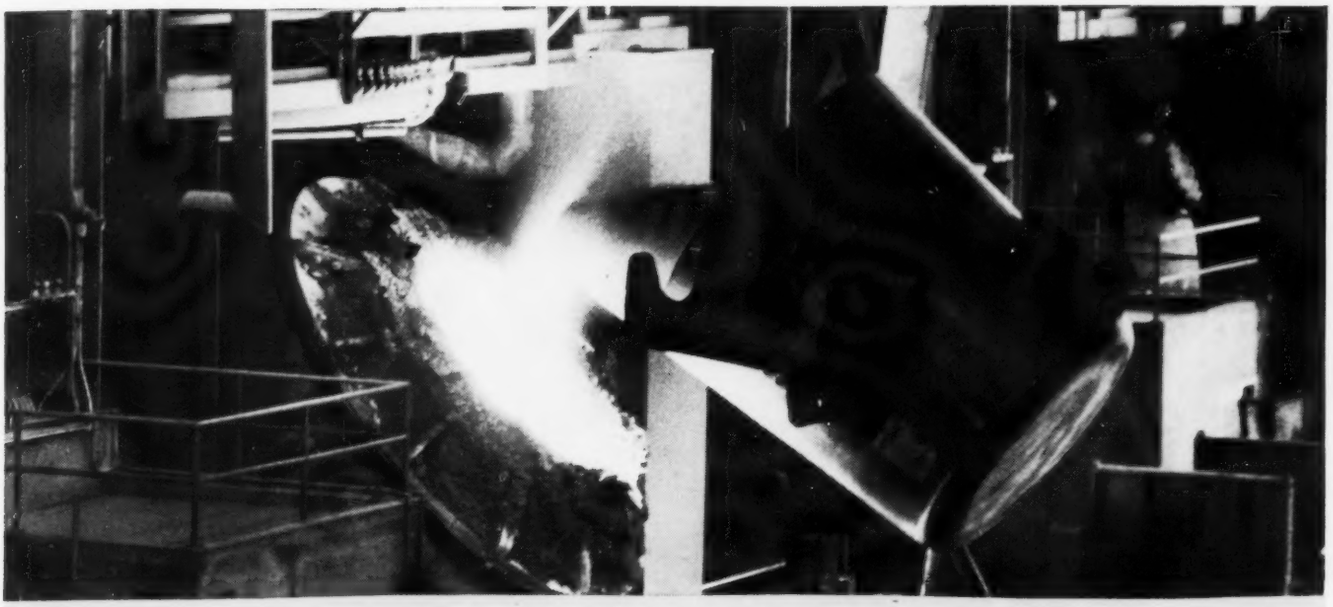
OFF-THE-SHELF DELIVERY is offered by Link-Belt on more than 15 types and over 300 sizes of babbitted and bronze bearing pillow blocks in cast iron or cast steel . . . for commercial shafting up to 12″ diameter. Also immediate delivery on flanged blocks and takeups in all popular sizes. Book 2707 contains helpful information on the selection and application of these bearings. For your copy, contact your nearest Link-Belt office or authorized stock-carrying distributor. Look under BEARINGS in the yellow pages of your phone book.

LINK-BELT

BABBITTED AND BRONZE BEARINGS

15,372

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sidney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa Springs. Representatives Throughout the World.



AT KAISER'S FONTANA WORKS . . .

BASIC OXYGEN FURNACES BY PECOR

America's first 15 oxygen steel furnaces have been fabricated by Pennsylvania Engineering! All of these furnaces, as well as the variety of auxiliary equipment supplied, are earning for PECor a solid reputation for equipment which stays-on-the-line making steel.

With a rich background of experience in this highly specialized product, Pennsylvania Engineering can contribute significantly to any oxygen steelmaking installation. With a PECor Oxygen Furnace you are assured of precision fabrication, smooth operation and on-the-spot service.

May we discuss oxygen steelmaking with you?

Illustrated above . . . one of three Pennsylvania Engineering furnaces in an L-D Process installation at Kaiser Steel Corp., Fontana, California.

BASIC OXYGEN FURNACE (L-D) SCOREBOARD
BUILT OR BEING BUILT BY PECor

Steel Producer	Furnaces	Rated Capacity
Jones and Laughlin Steel Corporation	4*	2 @ 65/100 Tons 2 @ 162/200 Tons
McLouth Steel Corp.	6	3 @ 110 Tons 3 @ 60 Tons
Kaiser Steel Corp.	3	65/100 Tons
Acme Steel Company	2	50 Tons

*When two new 162/200 ton furnaces are operating.

Pennsylvania Engineering
CORPORATION NEW CASTLE, PA.
Sales Representatives: Wooldridge Company, Burlingame, Calif., Fred Middleton Co., Inc., Birmingham, Ala.
Licensees: Ashmore, Benson, Pease & Company, Ltd., England; Kawasaki Dockyard Company, Ltd., Japan
BUILDER OF AMERICA'S FIRST 15 OXYGEN CONVERTERS

a salute to one of America's finest . . .

KAISER STEEL

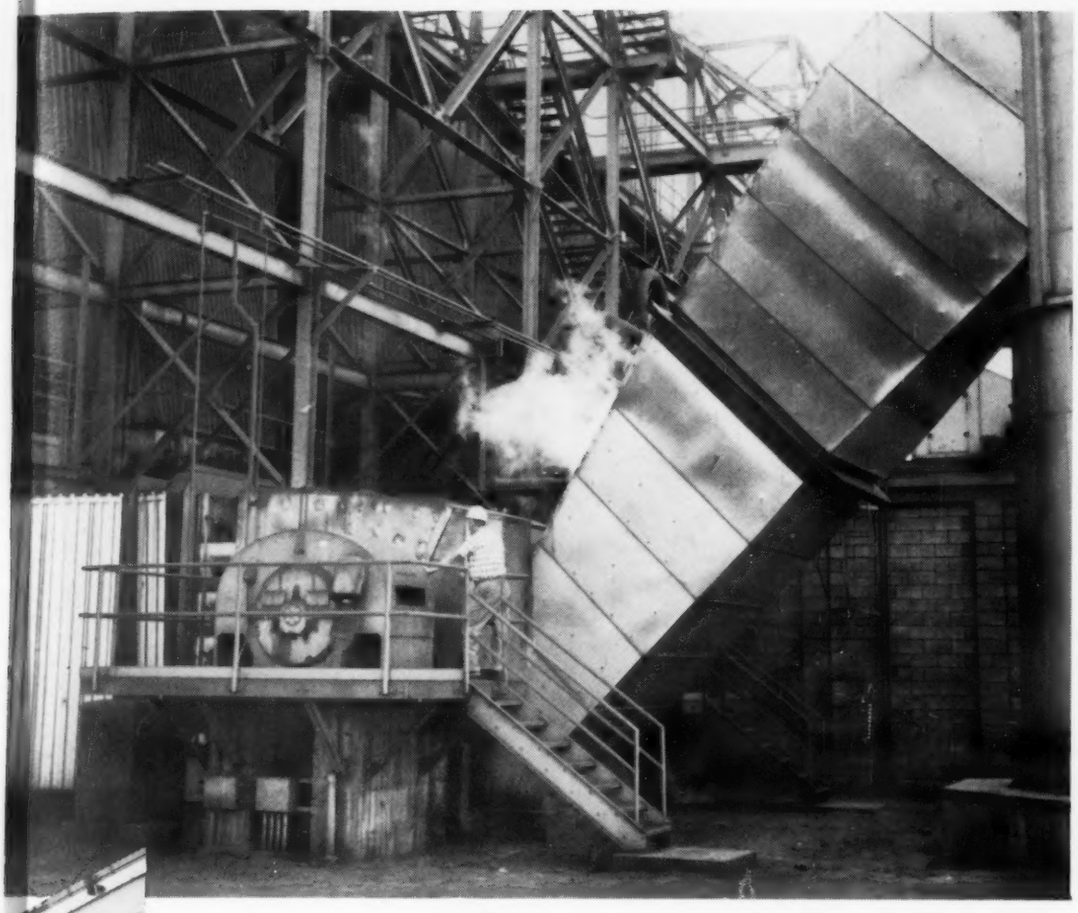
from one of its proudest suppliers

WHIRLEX

The KAISER STEEL Fontana Works, Fontana, California, beginning with Open Hearth Furnaces in 1943, and later adding the L-D Oxygen Process, is the West Coast's first and only completely integrated steel mill, a wonderful tribute to the forward-moving operations of a young giant . . . KAISER STEEL.

FLY ASH ARRESTOR CORP., makers of the famous WHIRLEX equipment, furnished the exhaust fans for KAISER STEEL'S L-D Oxygen Process Plant at Fontana. WHIRLEX "tailored" planning gives special study and handling with all units specifically designed and constructed for each particular job.

FLY ASH ARRESTOR CORP. is proud that WHIRLEX equipment takes a part at KAISER and is installed in its new L-D Oxygen Process at Fontana.



This equipment includes three airfoil induced WHIRLEX draft fans and separate system dampers. They were designed especially for gas distribution ducts, operating in connection with an electrostatic precipitator, and they handle the exhaust from the L-D Oxygen Process.

Because of its inherent characteristics, the WHIRLEX airfoil design gives the fans high efficiency at reduced horsepower.

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Bag Collectors • Mechanical Collectors • Wet Collectors • Induced Draft Fans • Forced Draft Fans • Exhaust Fans • Self Supporting Stacks • Duct Work

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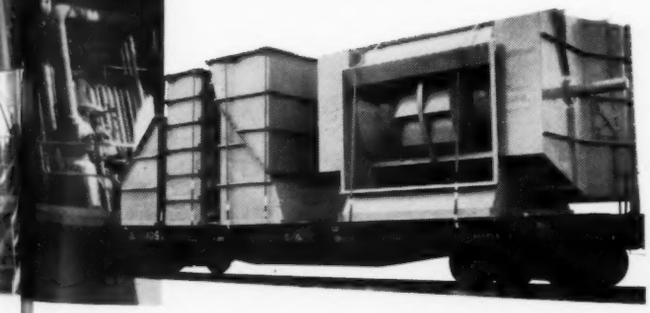

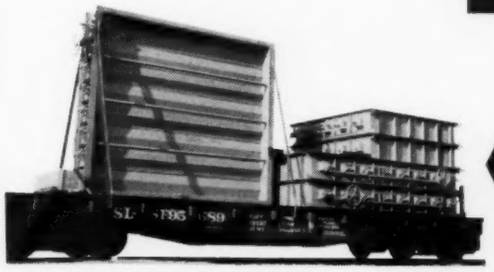

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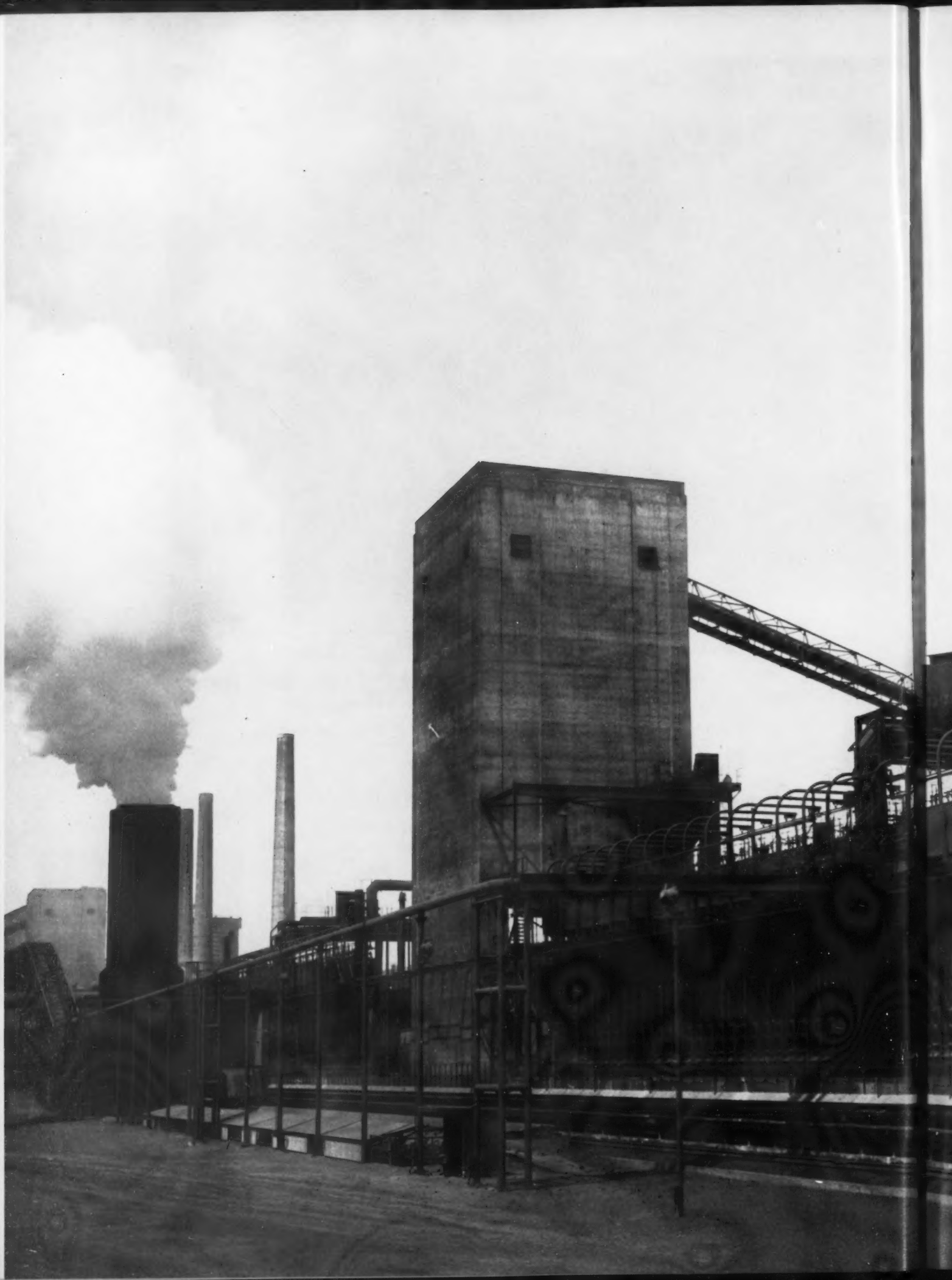
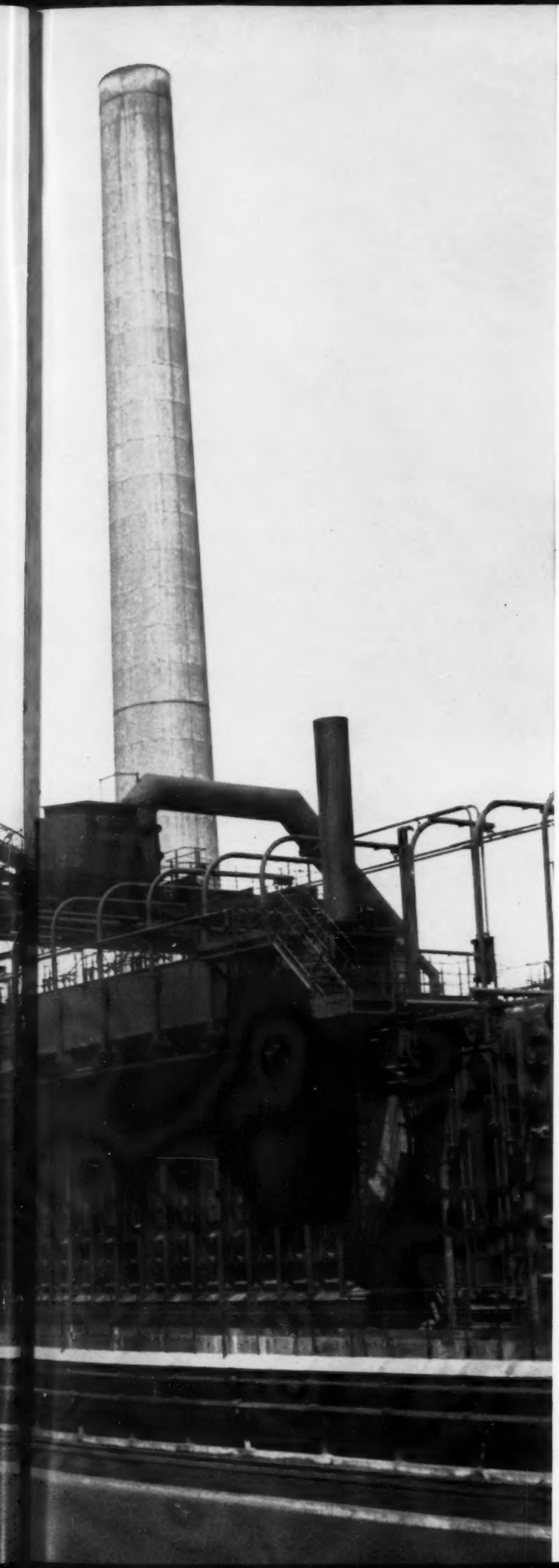




Kaiser's Fontana Plant has 315 coke ovens . . . all designed and built by Koppers

When the Fontana plant of Kaiser Steel Corporation was started almost 20 years ago, the contract for coke ovens was awarded to Koppers. Today at Fontana there are seven batteries of 45 coke ovens each. All of these ovens were designed and built by Koppers.

The first batteries, completed in 1942, were Koppers-Becker underjet ovens . . . the two most recently completed batteries, which went into operation in January, 1959, are Koppers-Becker gas-gun ovens. The total carbonizing capacity of all seven batteries is 6,600 tons of coal per day.

In addition to the 315 coke ovens, Koppers also designed and installed the coal-chemical, light oil, and material handling facilities at the Fontana plant.

For over 50 years Koppers engineers have been working with coke ovens: reducing operating costs . . . increasing yields of chemicals . . . improving heating controls. The majority of the coke ovens in the United States have been designed and built by Koppers.

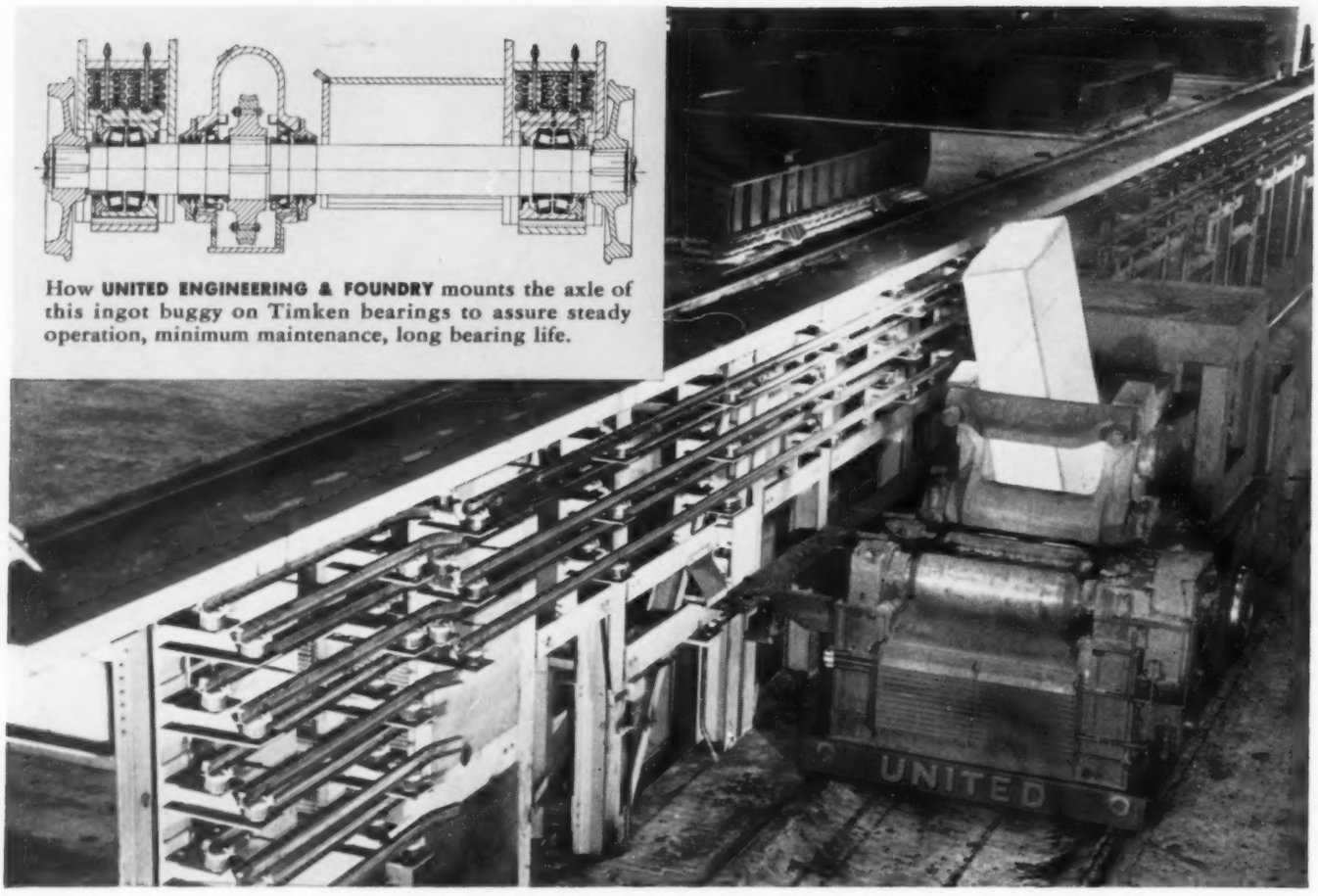
Koppers coke plant layouts are engineered to fit individual requirements, and to solve all coke plant problems associated with coal preparation and handling, coal-chemical recovery, light oil purification and refining, phenol recovery, and associated processes. Koppers also has excellent capabilities for repair and replacement work on coke ovens and auxiliaries.

Let us help *you* with your steel-plant expansion or modernization program. Just write or call Koppers Company, Inc., Engineering and Construction Division, Pittsburgh 19, Pennsylvania.

KOPPERS®

ENGINEERING and CONSTRUCTION

How **UNITED ENGINEERING & FOUNDRY** mounts the axle of this ingot buggy on Timken bearings to assure steady operation, minimum maintenance, long bearing life.



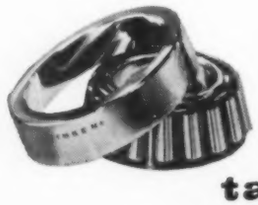
Keeps hot slabs moving fast with 27 Timken® bearings to keep it rolling

THIS United ingot buggy moves hot slabs and keeps 'em moving fast from a major steel producer's slab mill. To make sure the buggy moves the heavy loads steadily, with minimum maintenance, its builders, United Engineering & Foundry, equipped it with 27 Timken® *tapered* roller bearings. They're used on the axle drive worm shaft, axle journals, worm gear tilting drive worm shaft and tilting drive pinion shaft.

Timken bearings keep shafts aligned, gears meshing accurately. The tapered design of Timken bearings enables them to take any combination of radial and thrust loads. And full-line contact between rollers and races provides maximum stability. Cost-saving results are: shafts are held rigid; gears mesh smoothly and accurately; shaft wear is eliminated; gear wear reduced.

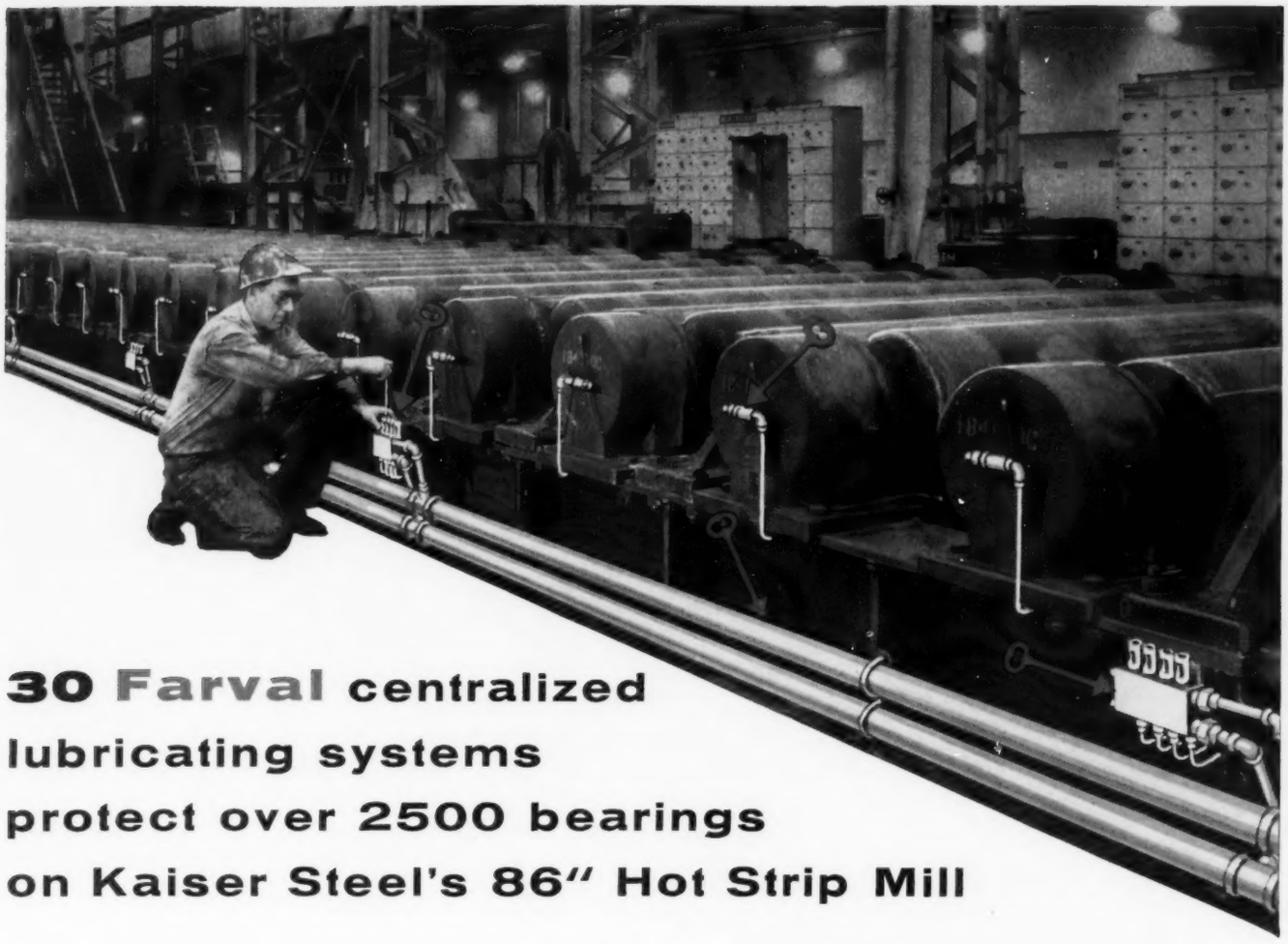
Any machine with Timken bearings gives you *extra* benefits—the benefits of Timken Company leadership in tapered roller bearing design and in engineering service. It's leadership backed by the most modern research and development facilities in the bearing industry. To get the most out of the machines you build or buy, specify Timken bearings. ***When you buy Timken bearings you get . . .*** *1) Quality you can take for granted. 2) Service you can't get anywhere else. 3) The best-known name in bearings. 4) The pace setter in lower bearing costs.* The Timken Roller Bearing Company, Canton 6, Ohio. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.* Canadian Division: Canadian Timken, St. Thomas, Ontario.

Industry rolls on



TIMKEN®

tapered roller bearings

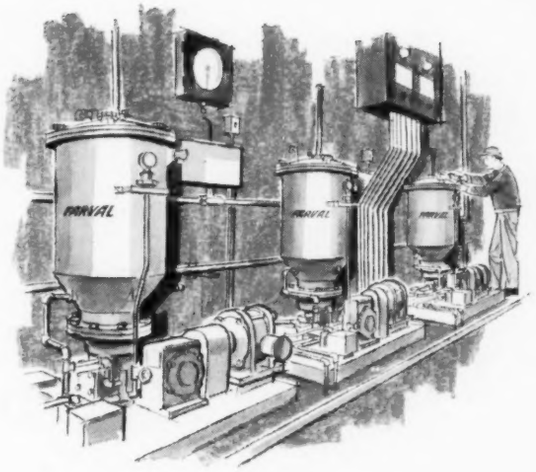


30 Farval centralized lubricating systems protect over 2500 bearings on Kaiser Steel's 86" Hot Strip Mill

Here on the mill table, between No. 4 and No. 5 roughing stands, Farval's positive, dependable lubrication is continuously on the job to prevent overheated, damaged bearings—costly mill shutdowns. A central bulk filling system is currently being designed and installed that will serve all the mill's Farval automatic stations.

On their 45 x 90-inch Universal Slabbing Mill, Kaiser engineers installed 15 Farval systems to serve over 1400 vital bearings. Also, 3 of Kaiser's 4 blast furnaces and over 100 different mill cranes get round-the-clock lubrication—thanks to modern engineered-for-the-job Farval systems.

Remember, for the ultimate in bearing protection—it's Farval. For the latest information on what Farval can do in your plant, write for free Bulletin 26-T.



• Three of many automatic, time clock controlled, end-of-line Farval Central Stations that serve Kaiser Steel's rolling facilities.

Farval Studies in Centralized Lubrication No. 254

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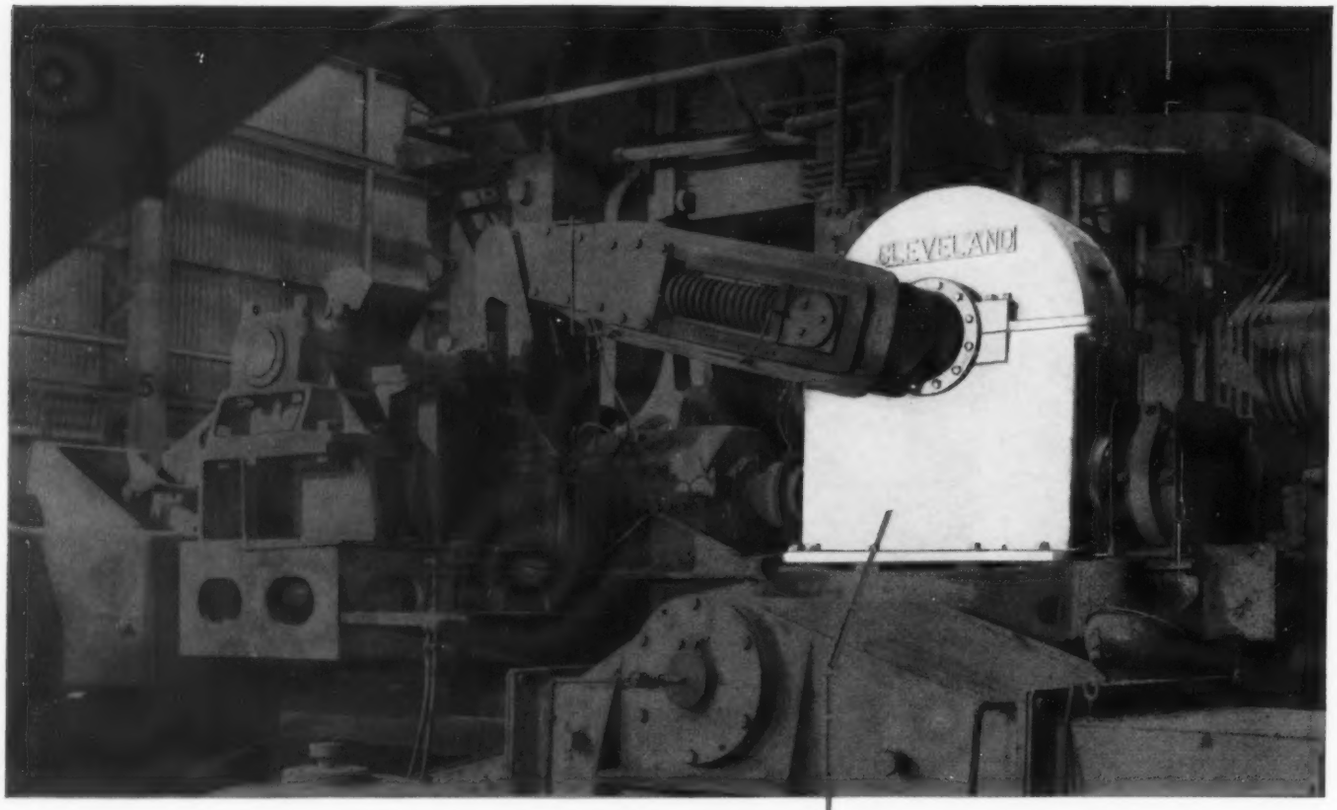
KEYS TO ADEQUATE LUBRICATION

Wherever you see the sign of Farval—familiar valve manifolds, dual lubricant lines and central pumping station—you know industrial equipment is being properly lubricated.

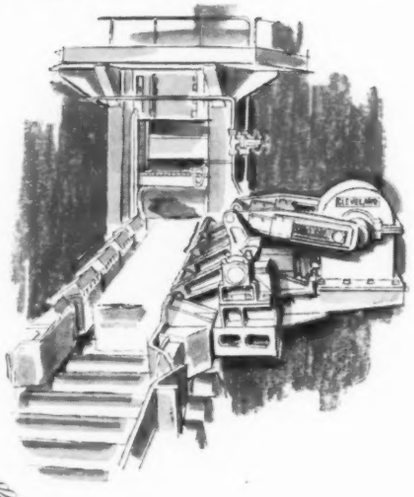


Two Cleveland Speed Reducers drive "Magic Fingers" on Kaiser Steel's New Slabbing Mill

Here's one of two rugged 3000-AT Cleveland Worm Gear Speed Reducers busy at work driving the manipulator finger lift mechanism on Kaiser Steel Company's new 45 x 90-inch Universal Slabbing Mill at Fontana, California. With these Cleveland Reducers, mounted on the slab pusher, turning massive slabs between mill passes is a simple, rapid operation.

In these large, yet compact, space-saving Clevelands, worm and gear shaft bearings are supported by a massive internal structural framework that enables the units to withstand extreme shock loads. Their right angle shaft arrangement provides a distinct advantage over other forms of gearing that might not fit the space limitations of a specific installation.

In all types of industrial plants, wherever rugged, compact and dependable speed reducers are needed, Clevelands handle the toughest assignments. Call your Cleveland Representative today, or write for Bulletins 145 and 410-A to get complete information on how to handle your most demanding power transmission jobs.



Cleveland Worm & Gear Division
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CLEVELAND
Worm Gear
Speed Reducers

DUCTILE IRON IN STEEL MILLS

Ductile iron, proven in many applications, should be carefully evaluated as a means of reducing initial cost and maintenance.

by C. R. ISLEIB
Metallurgist, Ductile Iron Div.
The International Nickel Co., Inc.,
New York, N. Y.

IT has been ten years since the first commercial heat of ductile iron was cast. In this short time this new material has proved itself in steel mills throughout the world in hundreds of applications involving wear, corrosion, strength and toughness. In 1959 over 100,000 tons of ductile iron were used in steel mills all over the world, and in 1961 this tonnage will triple.

Ductile iron castings are made in over 500 licensed foundries in the world; 200 in the United States and Canada. In steel mills ductile iron has been selected for equipment parts and for general maintenance castings where dependability, service life and economy are the overwhelming considerations; for rolls where high hardness and wear resistance of the roll face are combined with strength and toughness in the core, shoulders and wabblers; and for ingot molds where its superior mechanical properties pay dividends in reduced mold consumption per ton of steel produced.

METALLURGY OF DUCTILE IRON

Ductile iron (sometimes called nodular iron, spheroidal graphite iron or graphitic steel) embraces a family of ferrous materials with the common feature of having free graphite present in spheroidal form.

A small amount of residual magnesium, added to the molten blast furnace or cupola iron by plunging or reladling, results in any free graphite precipitating in spheroidal rather than flake form as illustrated by Figures 1 and 2. Thus a continuous steely matrix is achieved, and critical parts of high strength and toughness can be produced. A typical percentage analysis of a ductile iron used in castings in a steel mill is:

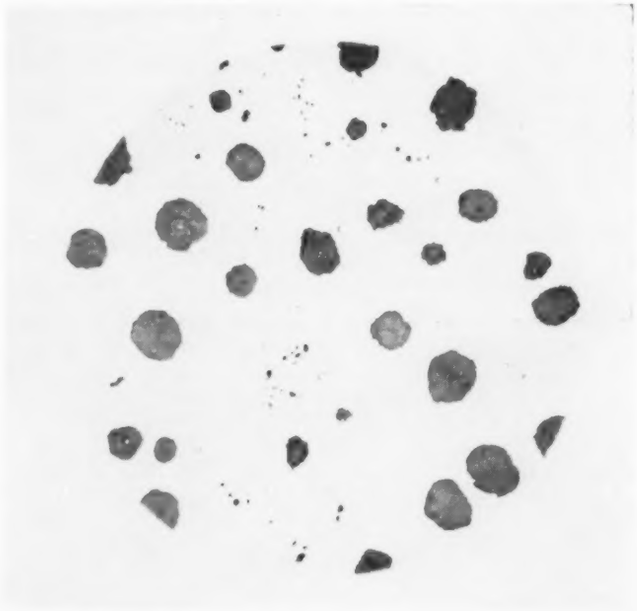
Total carbon	3.60	Sulfur	0.01
Silicon	2.5	Phosphorus	0.05
Manganese	0.25	Magnesium	0.05

PROPERTIES

Experience has shown that ductile iron castings are generally superior in resistance to wear, corrosion and

Figure 1 — Gray cast iron photomicrograph shows the typical flake graphite structure.

Figure 2 — Ductile iron photomicrograph shows the carbon as precipitated in spheroidal form.



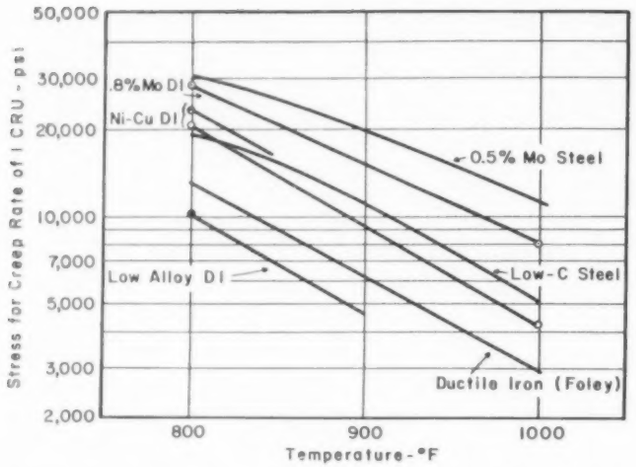


Figure 3 — The creep data indicates that 0.8 per cent molybdenum ductile iron is better than low carbon steel.

high temperature oxidation and warping. Ductile iron is characteristically tough and strong and has unusually high yield strength and stiffness. At elevated temperatures the creep strength of ferritic ductile iron is comparable to that of mild steel, and an 0.8 per cent molybdenum ductile iron has creep strength comparable to 0.5 per cent molybdenum steel, see Figure 3.

Ductile iron is extremely versatile. It can be used as-cast, annealed for maximum toughness and ductility, alloyed, quenched and drawn for highest strength or flame hardened for maximum wear resistance.

The matrix structure, as in steel, can be pearlitic, ferritic, acicular or a combination of these. Table I shows the range of mechanical properties that can be developed from a single heat of ductile cast iron.

DESIGN ADVANTAGES

The excellent castability of ductile iron permits designers to replace many fabricated assemblies with single ductile iron castings with improved engineering design and in almost all cases with substantial savings in cost. Two examples of this are gear cases and machine frames so often fabricated at high cost.

MACHINING

Lower machining costs are an important part of the economy realized through the use of ductile iron. Machinability is improved by the free graphite present. Ferritic ductile iron is most easily machined and machinability decreases in the stronger and harder grades. The ranges of speeds and feeds at which ductile iron can be machined economically have been determined and published in the book "Machining Ductile Irons." At equivalent hardness values below 300 Bhn, higher machining speeds can be used for ductile iron with longer tool life expectancies as compared with steel.

TABLE I
Properties Developed From One Ductile Iron Through Heat Treatment—(One In. Section)

Total Carbon	Silicon	Manganese	Phosphorus	Nickel
3.50	2.75	0.35	0.04	1.00
Condition	**Tensile strength, psi**	**Yield strength, psi**	**Per cent elongation**	**Bhn**
As-cast annealed	105,000 66,000	70,000 51,000	6 20	240 155
Normalized and drawn	134,000	91,500	8	275
Oil quenched and drawn	152,000	136,000	4	315

ROLLING MILL APPLICATIONS

Metal-working rolls and auxiliaries—Ductile iron offers the rolling mill engineer the wear resistance and good frictional properties of cast iron with strength approaching that of steel. This has proved an outstanding combination of properties for metal-working rolls, and the production of rolls (see Figure 4) has become one of the major applications of ductile iron in many parts of the world.

The types of ductile iron rolls used in steel mill practice cover a very wide range. Pearlitic and acicular rolls, measuring up to 50 Shore hardness, and chill cast rolls from 50 to 70 Shore, are being used now. The development of acicular ductile iron work rolls with a surface hardness of 80–85 scleroscope is now in the experimental stage.

At present two outstanding, well-accepted advantages for ductile iron work rolls are these:

1. Where the body of a roll must be machined into grooves or forms, ductile iron rolls machine far better than flake iron rolls at equivalent hardness levels. Grooves whose edges crumble or chip in hard flake iron rolls machine beautifully in hard spheroidal graphite iron rolls.

2. Chill-cast ductile iron work rolls have an even chill to a much greater depth than grain iron rolls. At half-life the hardness level of ductile iron rolls is near their original hardness. Their life is generally longer and they can often be redressed more times than grain iron rolls.

Ductile iron rolls have replaced some cast steel rolls for hot work in bloom and slab mills, and have shown some promise for backing rolls in 4-high mills. Their main uses in this country, however, have been to replace grain rolls where they are not satisfactory, and to replace sand-cast rollers and guides in auxiliary equipment.

Run-out table rolls, gears and gear covers—Run-out table rolls as shown in Figure 5 are a well-proved application because of ductile iron's resistance to impact, excellent wearing qualities and ease of machining for redressing. Ductile iron has shown better resistance to wear and scaling than both steel and cast iron rolls, better toughness than gray cast iron rolls, and better machinability than steel rolls. Reports show that in this application ductile iron rolls have given three times the life of flake iron rolls. They are generally used pearlitic, (sand-cast) but can be surface hardened. In some cases where bronze bearings were employed for table rollers, it was found that the bronze could be eliminated because of the good bearing properties of the ductile iron.

Skelp mill work rolls—Skelp mill grain work rolls are subject to severe overheating and cracking. One mill has standardized on chill cast ductile iron work rolls for this application with far better performance records.

Pole shoe mill—Rolls for this operation tend to wear excessively toward the outer edge because the shoe is cooler and harder in those thinner sections. Ductile iron rolls have given excellent results for this service.

Slabbing mill roll sleeves, bar mill rolls—In these applications, ductile iron has replaced forged and cast steel respectively, resulting in longer life and much easier machining in redressing.

Tube and pipe mill sizing rolls, idler rolls and conveying rolls—Ductile iron rolls have replaced cast iron grain rolls and alloy steel rolls with superior wear resistance and resistance to fire cracking.

Ductile iron pipe conveying rolls at 175 Bhn do not scratch pipe, nor are bushings necessary because of the nongalling characteristics of ductile iron.

Guides, apron, plates and side guard inserts—Ductile iron resists wear and warpage far more than cast and wrought steel in these applications (See Figure 6) and eliminates breakage experienced when cast iron is used for these parts. In many cases these parts cost less in ductile iron than in cast steel.

Strip mill rollers—In several countries, ductile iron has become established for many other rollers required in modern continuous strip mills. Deflecting and tensioning rolls and guides, stacking rolls and strip coiler rolls are a few examples. The rollers, in various sizes, are generally hollow cast and mounted on steel mandrels. Ductile iron in these applications provide excellent finish and better wear resistance than gray iron or steel, preventing scratching of the strip. They are frequently surface-hardened up to as high as 60 Rockwell C.

Furnace doors and soaking pit covers—Ductile iron doors and door frames as shown in Figure 7 for reheating furnaces result in a better seal and less maintenance costs. Again, this is because of ductile iron's greater resistance to oxidation, cracking and warping at high temperatures.

Soaking pits are an excellent field for the application of ductile iron. Here service conditions are severe and gray iron is usually ruled out because of lack of toughness. Ductile iron has been successfully established for frames and covers for soaking pit furnaces. The illustration shows the application of ductile iron to send seal plates on soaking pit covers; warping and distortion with consequent gas leakage are minimized.

Cooling banks—Ductile iron has been adopted for many of the details of steel plant cooling banks, where finished products such as rails, plates, etc., are left to cool after rolling. For plates, disc rollers in ductile iron have proved durable and economic, and lifter bars for rails and other parts of manipulating machinery in contact with the hot metal have also successfully been made in the material.

Annealing stands and trays—This is another example where the heat resistance of ductile iron when used in place of gray iron or steel, leads to long life and less distortion.

COKE PLANT

Ductile iron is now established in the construction of modern coke plants throughout the world. Some examples of its performance follow.

Oven doors and frames—Ductile iron is extensively

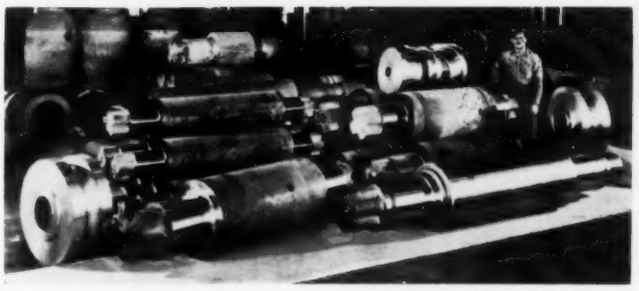


Figure 4 — Many types of metal working rolls are being made of ductile iron.

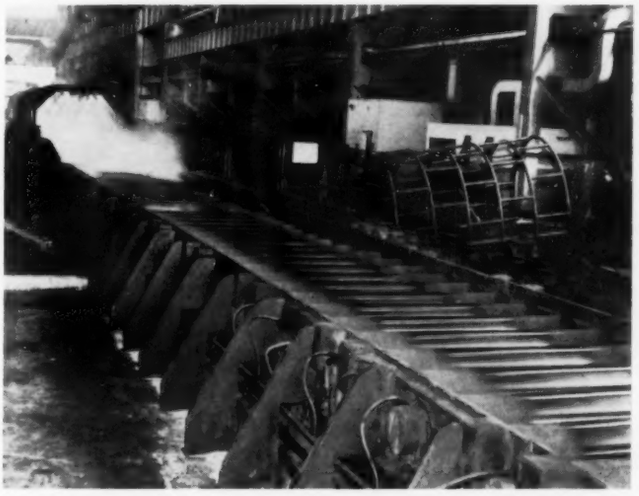


Figure 5 — Resistance to impact, ease of machining and excellent wear properties have prompted the use of ductile iron for runout table rolls.

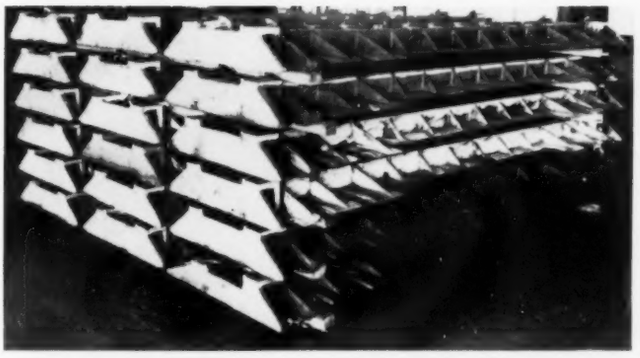
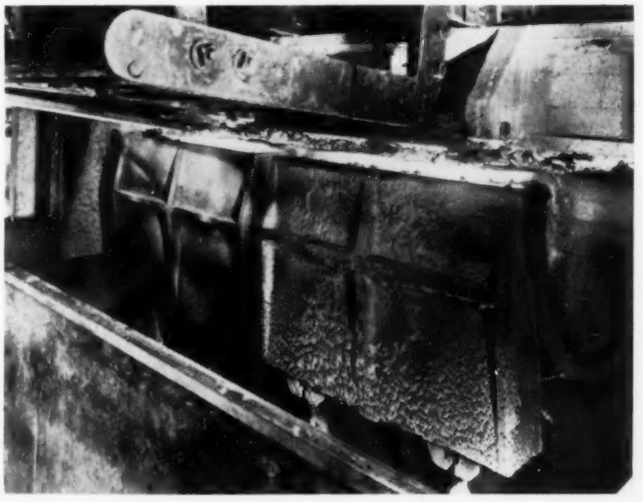


Figure 6 — These apron plates withstand the severe impacts that occur in service.

Figure 7 — Ductile iron doors operate at 2100 F.



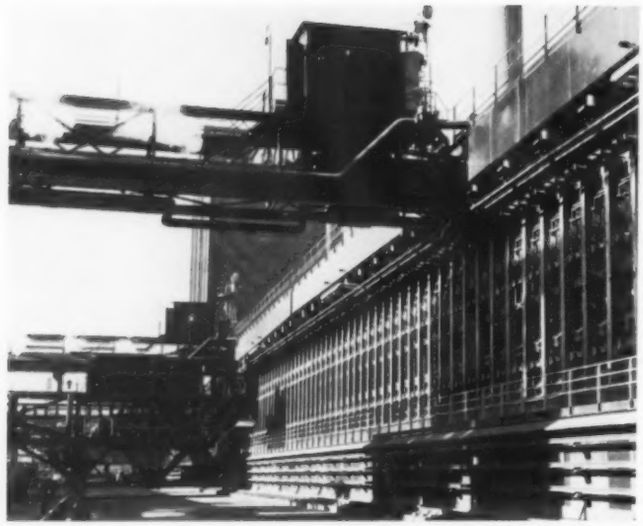
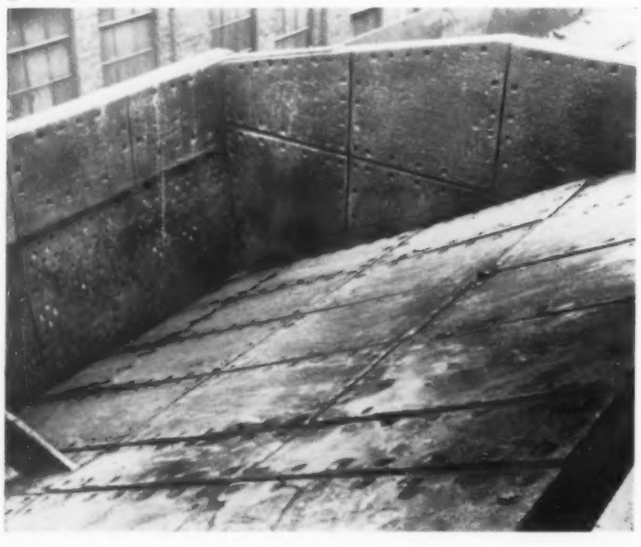


Figure 8 — Less door warpage and maintenance costs resulted from the application of ductile iron for coke oven doors.

Figure 9 — Ductile iron pipe sections are better able to expand and contract under thermal cycling.

Figure 10 — The application to coke cars has resulted in greatly extended service life.



used, replacing gray cast iron, for coke oven doors and frames, Figure 8. The lower rate of oxidation and growth shown by ductile iron, leads to longer life, lower maintenance costs and less loss of gas through leakage. Elimination of breakage during installation or servicing of the ovens is another important factor. The higher strength of ductile iron doors has made possible the reduction of the section thickness of the door castings. Because of the weight reduction these ductile iron doors have the added advantage of being easier to install and operate. Due to the higher strength of ductile iron it is also possible to cast the hook supports and lugs as integral parts of the door. In service such doors have given double the life of the gray iron doors previously used.

Experience with door frames has been similar and since each coke oven plant carries a large number of doors and frames, the overall economy realized by adopting ductile iron has proved considerable. Ductile iron door-liner retainers have replaced similar parts in gray iron. Here the durability of ductile iron and its lower rate of oxidation and growth have given improved life and have reduced liner-maintenance costs.

Charger-hole frames and covers—The better resistance to expansion and growth and the higher mechanical properties of ductile iron have reduced maintenance on charging-hole plates and lids. When made in gray cast iron, failure in these parts occurs by oxidation of the inner diameter of the charging-hole and by growth and distortion, thus making a tight seal with the lid relatively impossible. The life and efficiency of ductile iron charging-hole plates and lids are reported to be at least twice those obtained when gray cast iron is used.

Gas-ascension elbows—Oxidation and growth lead to heavy maintenance costs on hot-gas lines, where it is essential to maintain efficient seals at flanged joints. On several new coke plant installations ductile iron has been adopted as standard for pipe, and it has been found that in addition to its better resistance to growth and oxidation, the pipe parts are better able to expand and contract under heat without the danger of cracking common to gray-iron. See Figure 9. For several items, section thickness has been reduced with, at the same time, improved service performance. The use of ductile iron on hot-gas lines points also to the economies it offers for dampers, valves and so on.

Charging-machine pusher heads—Because of the better resistance of ductile iron to heat, wear and shock, several applications have been established in the charging equipment and other machinery associated with coke ovens. Among these items are charger pusher heads, for which ductile iron has given good service.

Quenching car liner plates and doors—An application of ductile iron which demonstrates strikingly the service economy which it offers is coke-quenching car liner plates and fittings. These cars receive the incandescent coke as it is discharged from the ovens and are consequently subject to heat and shock and to the abrasive effects of the coke. After receiving the charge the car is transferred to the water spray station where the liner plates have to resist water quenching and at the same time, the corrosive effects of the sulphur compounds and other impurities washed out of the coke during quenching. The conditions to which coke car liners are exposed are so severe that in many cases gray cast

iron plates have insufficient strength to resist the impact and thermal shock. Steel plates, on the other hand, show not only a higher rate of corrosion and wear, but in contact with the hot coke, they rapidly become warped and distorted.

In one case coke cars had been constructed with end and bottom plates of 1¼-in. boiler plate steel, and doors in gray iron. Maintenance was heavy, the steel plates warped so rapidly that they often ruptured the steel holding bolts, while the gray iron doors cracked and had to be patched every two or three months. Corrosion was severe resulting in a short life for the whole car. After preliminary tests, ductile iron was adopted for bottom and side plates and doors. See Figure 10. The bottom plates were still in good shape after 18 months' service, which is five times the life of the steel plates previously used. For the doors the ultimate life was three times the full life of the gray iron. The plant in question has now standardized on ductile iron for all the parts that come into contact with the hot coke.

SINTER PLANT

Pallet frames and side plates—Many modern steel plants use sinter machines for the agglomeration of finely divided iron ore, flue duct, etc., to prepare them for charging to the blast furnace. The mineral is mixed with coke dust and is ignited on a continuous chain of pallets each of which consists of a frame on which are supported grate bars. Since combustion of the charge is forced by suction on the under side of the pallets, the grate bars and frames are subjected to high temperature conditions, and because warpage must be reduced to a minimum, heat resistance in these parts is essential. Following extensive tests with ductile iron for pallet frames, several users have now standardized on it and reports from many parts of the world indicate that this is an outstandingly successful application of ductile iron, Figure 11.

Ductile iron end frames and side plates are widely used to eliminate breakage and decrease warping and oxidation of these parts. Several plants have had good success using ductile iron wheels hardened to 55 to 60 Rockwell C.

BLAST FURNACES

Charger bells and throats—Many large and small castings are involved in the construction of modern blast furnace equipment. Heat resistance, high mechanical strength and shock resistance are all required to meet the severe conditions encountered in service. For example, the charger wear plates in the top of the furnace (Figure 12) are subjected to the impact and wear of the charge as it is projected into the furnace. Quenched and tempered ductile iron is ideal for applications of this type where shock resistance under abrasive conditions is essential. Similar applications include the hopper segments between the upper and lower charger bells.

Hoist drums and sheaves—Many details in the hoist equipment of the charger mechanism of blast furnaces can, with economy, be made from ductile iron. This is in line with general engineering practice in the U. S. where the improved wear resistance of ductile iron

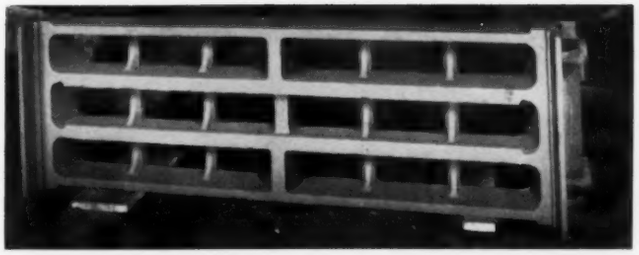


Figure 11 — Ductile iron pallet frames withstand high temperature conditions with minimum warpage.

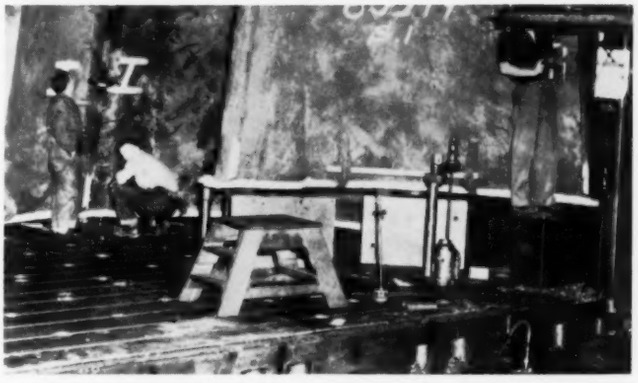


Figure 12 — Large castings subject to impact and wear are made of quenched and tempered ductile iron.

Figure 13 — The use of ductile iron charging boxes has been an outstanding application.

gears, pulleys, sheaves, etc., is well established. For these and similar applications heat treated ductile iron castings are considered the best to meet the heavy duty service involved.

Pig-casting machines—Here again the improved mechanical properties of ductile iron make it suitable for the replacement of gray iron or steel for many mechanical details such as casting-machine wheels, links and bushings. In this connection the good bearing properties of ductile iron under arduous conditions are of particular advantage. For bearings and bushings the oil quenched and tempered grade of alloyed ductile iron is recommended.

MELT SHOP

Furnace castings—The service conditions involved in and around open hearth furnaces are extremely severe, and here again for general castings ductile iron offers economy because of its heat resistance and freedom from warpage. Ductile iron has proved itself satisfactory for damper equipment.

Some uses in open hearth furnaces are soot blower nozzles and clamps where greatly improved service and reduced maintenance have followed the replacement of gray iron for these items; for this type of

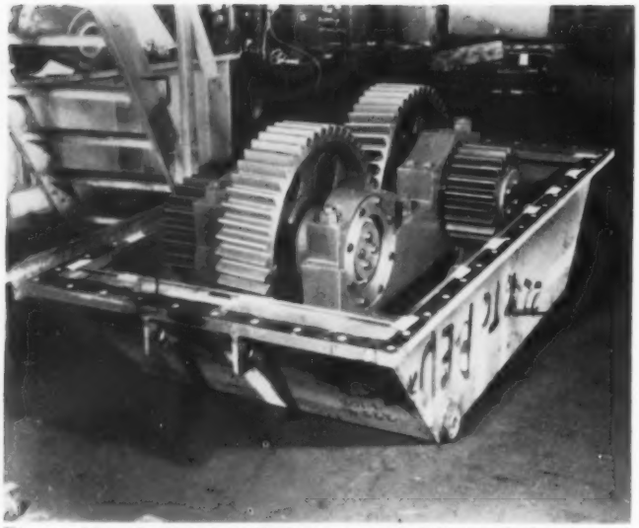


Figure 14 — Large ductile iron gears withstand shock and heavy loads and are easily machinable.

Figure 15 — One of the largest briquetting machines in the world uses a ductile iron ram.

service nickel containing ductile austenitic ductile iron or any combination thereof is outstanding.

In this country ductile iron has replaced cast or fabricated steel for hot metal spouts or runner boxes and also for slag spouts. Several mills have adopted ductile iron as standard for these items because of the reduced warpage and the consequent reduction in troublesome maintenance. Another application is the replacement of gray iron or steel for runner box supports. Here the breakage of cast iron supports was eliminated, and the warpage and high production cost of steel supports avoided.

Open hearth charging boxes—Perhaps the outstanding application of ductile iron in steel mills is for charging boxes for open hearth furnaces as illustrated by Figure 13. Ductile iron boxes, after comparable service, show less burning than do the steel boxes and warpage and cracking are greatly reduced. This is particularly important since in steel boxes the tendency is for the sides to cave in thus reducing both the capacity and efficiency of the charger boxes. Steel boxes generally develop cracking at the peel ends after six months' service, whereas ductile iron boxes have been found free from cracks after one year in use. Experience to date indicates that the ductile iron boxes will outlast the steel boxes previously employed and will lower maintenance cost, as well as being lower in the first cost in most cases.

Slag pots—The heat resistance of ductile iron is valuable in slag pots where the toughness and strength of the ferritic grade are useful in resisting the rough handling to which the pots are exposed in service.

INGOT MOLDS AND HOT TOP CASINGS

Ingot molds—The ingot mold is one of the most promising potential uses for ductile iron in the entire industrial picture. Ingot molds represent a considerable item in the cost of steel to the consumer and a staggering item of total cost to the metals industry. Even more important, the quality of the ingot produced, the extent of surface conditioning or cropping costs necessary prior to rolling, may be an even greater factor in unit costs. A mold in which deterioration, cracking and gouging proceeds at a slower rate would raise the quality and lower the costs of the product ingots in a major way.

The mechanical properties of ductile iron make it a good material in heat shock applications. Further, the high mechanical properties enable ingot molds to be reduced in wall thickness 25 to 40 per cent compared with conventional cast iron molds. This reduction in wall thickness also compensates for the lower thermal conductivity of ductile iron compared with flake graphite iron. Molds made of ductile iron can withstand the roughest use without breaking.

At present, ductile iron ingot molds are being tested in several parts of the world, including the U. S., where at least five major test programs are under way. Molds for ingots ranging in size from one to 20 tons are being tested.

SUMMARY

Most of the applications referred to in this paper are particular to steel plants. However, in any steel plant there are many other locations where ductile iron will be of interest in reducing maintenance and in saving costs in general equipment. Among such items are components of transfer cars, including car wheels, gears, pulleys, sheaves and racks (See Figure 14). Ductile iron pipe is now available for high pressure hydraulic pipelines, valves and fittings; it is also used for high pressure hydraulic cylinders (as shown in Figure 15). Ductile iron is now well established for manhole covers and frames, small turntables, and rainwater drain grates where these parts lie in positions in which they are subject to heavy loads and impact. Lifting gear is another item where ductile iron can be usefully employed for parts subject to hard service.

The ease with which ductile iron may be cast in the foundry makes it attractive as a material for the rapid production of castings for maintenance purposes. For example, parts of charging machinery, rolling mill equipment, etc., which must be replaced at short notice may often be made in ductile iron thus reducing expensive shutdowns to a minimum.

Reliability and quality control—Reliability of component parts is perhaps more important to steel mill

Figure 16 — Easily machinable, quality castings are consistently produced by capable foundries.

operators than any other single consideration. The reliability of any material or manufactured part is dependent on the skill and quality control exercised by its maker. Capable ductile iron foundries consistently produce castings and finished parts of very high integrity (See Figure 16) because of their strict quality control procedures.

A producer may use one of three quality control methods to assure that the spheroidal graphite structure and the high mechanical properties expected of ductile iron are under control:

1. Microexamination of a lug or test piece poured with the castings.
2. Tensile test on a test piece poured with the castings.
3. Chemical or spectrographic analysis for magnesium.

In addition, fracture tests are often used on the foundry floor as a quick check on graphite structure.

Quality control tests are regular and systematic; their frequency depends on the production method being used and the use being made of the casting produced. Foundries, where ductile iron is a major part of the business, develop and use procedures which result in consistently high quality products.

Brinell hardness tests control the proper matrix structure; a definite relationship exists between the hardness value and the mechanical properties of ductile iron.

The user and the producer of ductile iron castings should agree on the quality control that will be used bearing in mind cost, use of the casting and the quality control that would be demanded of a competitive material.

The purchaser and user of ductile iron castings can be sure of the outstanding service and the consistently excellent properties he expects of ductile iron when his supplier produces under controlled conditions.

Ductile iron castings are now being purchased under ASTM specifications A-339, A-395, A-396; military specifications I-11466 (Ord.), I-17166A (ships) and I-18397 (ships); AMS specifications 5315, 5316 and 5394; and to internal specifications of many large corporations.

Welding ductile irons—Ferritic ductile iron is readily weldable using electric arc, oxyacetylene and high frequency induction-pressure methods, when proper procedure is followed. Welds will be strong, pressure-tight and will have adequate ductility and toughness for uses involving steady loads, see Figure 17.

In order to arc-weld ductile iron successfully, some simple rules have to be followed:

1. Composition. Ductile irons containing minimum amounts of phosphorus and those alloys promoting hardenability, respond best to welding. A nominal percentage composition of 3.6 C, 2.4 Si, 0.3 Mn, 0.5 max. Ni, 0.05 P responds well to welding using several processes.

2. Microstructure. Ferritic ductile iron is most readily weldable, though pearlitic structures can be welded.

3. Casting surface. This should be clean, free of sand, scale, oil and other dirt or sulphurous coatings. Greasy castings should be cleaned with a solvent or by torch heating to 750 F.

4. Welding amperage. Should be kept low

Electrode size	*Amp*	
in.	*D-C*	*A-C*
3/32	50–80	60–90
1/8	90–110	100–120
5/32	120–140	130–150
3/16	140–160	150–170

These amp ranges are for flat or downhand welding positions. They should be reduced by 5 to 15 amp for overhead welding, 10 to 20 amp for vertical welding.

5. Electrode manipulation and welding sequence.

Figure 17 — Ferritic ductile iron is readily weldable using electric arc, oxyacetylene and high frequency methods.

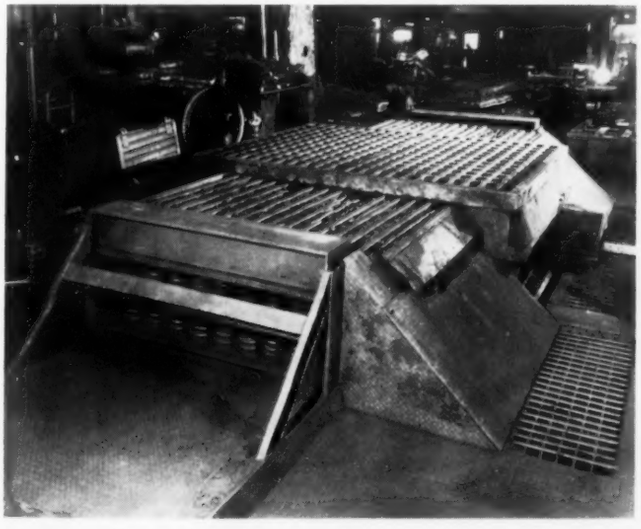


TABLE II
Mechanical Properties Of Nickel-Iron Arc-Welded Joints In Ductile Iron

	Tensile strength, psi	Yield strength, psi at 0.20 per cent offset	Per cent elongation
Ductile iron plate before welding	60,000	45,000	20
As-welded	60,600	44,500	6 max.
Annealed after welding	60,500	42,500	12 max.
As-welded, 1000 F preheat	62,500	44,750	5–9
Annealed after welding, 1000 F preheat	62,700	42,400	12–17

Continuous welding is recommended still using a staggered procedure to get reasonably uniform distribution of heat in all parts of the weldment.

6. Peening. Recommended to relieve stresses, especially after laying heavy beads. Peening should be with repeated moderate blows rather than a few heavy blows.

7. Rod. Coated austenitic rod of the 60 per cent nickel-40 per cent iron composition has been used most widely. Low hydrogen mild steel rod can also be used successfully.

8. Post-treatment. To achieve maximum machinability, welded ductile iron joints can be annealed.

Examples of the properties that can be expected from welded joints in ductile iron are shown in Table II.

Oxyacetylene welding of ductile iron can be done using a cast ductile iron rod which deposits a spheroidal graphite bead.

With arc-welding, and to a lesser extent with gas welding, a metallurgical change takes place in the zone adjacent to the weld because of the fast cooling following welding. An area about 0.09 in. wide will contain some carbides and higher transformation constituents which is the reason for the loss of ductility shown in Table II.

Discussion

PRESENTED BY

R. J. COLLINS, Area Design Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

R. F. ARMITAGE, Senior Assistant District Manager, Warren District, Republic Steel Corp., Warren, Ohio

G. M. KYLE, Assistant Superintendent, Mechanical Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

S. WOODRUFF, Roll Engineer, Bethlehem Steel Co., Bethlehem, Pa.

C. R. ISLEIB, Metallurgist, Ductile Iron Div., The International Nickel Co., Inc., New York, N. Y.

R. J. Collins: Some of the listed applications have been used in various plants at Jones & Laughlin Steel Corp., and very successfully. There have been several possibilities mentioned here that we have not tried, but we shall keep our minds open for special applications in the future.

On some of the applications we do not exactly concur. One application was runout table rolls. We prefer chilled iron rolls for runout tables. One of the reasons advanced is that, in order to get the surface hardness with ductile iron that is necessary to obtain increased wear, there are surface carbides that must be contended with. When the surrounding materials wear away it actually leaves high spots on the roll that will scratch.

We have been very well pleased with ductile iron rolls in our 14-in. merchant mill at Aliquippa. We roll a number of intricate shapes there, and feel it has been a very good application. The reason, as pointed out by the author is that the rolls can be machined much easier and the collars do not crumble away. This is very important to the success of this operation in our 14-in. mill.

We are interested in the advancement of other application of this material, especially in the use of backup rolls, work rolls for our strip mills, etc.

R. F. Armitage: The author touched on a cost figure early in his talk. Something in the order of 25 per cent of the cost above is going into repair and maintenance, and we have to search for ways to reduce that cost.

Certainly one of the most promising ways or means of effecting maintenance cost reduction lies in the development and application of new and better materials.

As in Mr. Collins' case, our experience with the material to date is rather limited by comparison with the uses that the author has mentioned. We can say it is sufficient to leave us with some mixed reactions. We certainly endorse the claims made in connection with the use of it for coke quenching car parts. Our quenching medium contains still waste and is, therefore, very highly corrosive. Ductile iron plates used for floor plates, doors and diaphragms for these cars have outlasted any other material at least two to one in our case. We have also had success with pusher ram shoes and various water hydraulic plungers. On the other hand, the service obtained from hot strip mill runout table rolls, strip mill guide inserts and sprockets for skelp mill conveyor chain was disappointing. Perhaps in these latter cases, the composition of the material that we were using was not just exactly what it should have been. Would you care to elaborate again on the influence of grade selection so far as performance of this material is concerned? We have the impression that the ductile iron roll is better for nonferrous material than it is for ferrous materials.

We would like to raise the question of whether or not the electric motor brake wheel is a good application for your material?

And in connection with welding of the material, are not high pre- and post-heat temperatures required to properly weld ductile iron?

G. M. Kyle: At Inland Steel Co. we have used ductile iron successfully on certain applications including that of runout table rolls on one of our hot mills. Obviously, this particular application is exposed to heat of the strip and to thermal shock from the use of water sprays. In addition, the ductile iron reduces scratching of the product.

Due to the difficulty of welding ductile iron, however, we avoid its use on highly stressed or critical units that cannot be repaired quickly to maintain production.

Would the author give us some idea of the initial cost of ductile iron?

S. Woodruff: We cannot comment on the application of ductile iron rolls in the nonferrous industry. However, for certain applications, primarily in merchant mills, ductile iron rolls have become increasingly popular in our corporation's mills. We find it advantageous for small sections where extremely narrow deep passes must be cut in small rolls.

In the chilled surface of these iron rolls, the ductile structure is more machinable, and so ductile roll iron lends itself to the machining of deformations in the passes of rolls used for deformed bar. You must understand that the ductile iron that is used in rolls is not at all similar to the ductile iron for most other applications. It is a highly carbidic material. We do not recommend it for increased strength, although we do find some. We do not recommend it on this basis.

Ductile iron has been used successfully in some skelp applications where the previous material was clear chilled roll iron, which will outwear the ductile iron if it withstands the thermal shock. Frequently the clear chilled rolls do not stand up under the thermal shock which is present in rolling wide skelp. We have found the ductile iron in skelp rolling to be a good compromise. It has withstood the thermal shock very well, and has a quite satisfactory wear pattern.

C. R. Isleib: We will answer the questions in order.

1. *Runout table rolls*—As-cast pearlitic or oil-quenched acicular ductile iron have proved best for runout table rolls to the best of our knowledge. These types do not scratch sheet because they are free from primary or massive carbides. Solid pearlitic runout table rolls resist breakage far better than gray iron or chill cast iron rolls; they outwear gray iron rolls. Hollow acicular, quenched and tempered runout table rolls resist wear better than quenched and tempered steel rolls when the service temperature is over 400 F, and do not snag or scratch the sheet as steel rolls sometimes do.

2. *Strip mill guide inserts*—Outstandingly good results have been obtained in some mills with pearlitic and oil-quenched and tempered guide inserts. Again, wear resistance and freedom from snagging were the outstanding characteristics of the ductile iron guides.

3. *Conveyor chain sprockets*—This application, too, requires a pearlitic or quenched and tempered acicular structure for optimum wear resistance.

4. *Brake disks*—High carbon and low silicon ferritic grades are successfully used now.

Broadly speaking, there are four main classifications of ductile iron.

1. Ferritic (60–45–15) ductile iron. This grade is toughest, most resistant to heat shock and most weldable. It usually contains about 3.6/3.8 per cent TC, 2.0/2.50 per cent Si, 0.25 per cent Mn and other elements present in residual quantities and measures 150–180 Bhn.

2. Pearlitic (80–60–03) ductile iron. This type is strong and wear resistant, often produced as-cast or as-cast and stress relieved. It usually contains 2.6/3.8 per cent C, 2.0/2.5 per cent Si and 0.4/0.7 per cent Mn and measures 220–250 Bhn.

3. Acicular (oil-quenched and tempered) ductile iron. This iron has the highest strength and best wear resistance, but least weldability. It may contain about 3.6/3.8 per cent TC, 2.0/2.5 per cent Si, 0.4/0.7 per cent Mn and 0.75/3.0 per cent Ni, measuring 260 to 315 Bhn or even higher.

4. Various specialties such as 3 to 4 per cent silicon ductile iron to resist corrosion at steady high temperatures; 1.0 per cent nickel–0.75 per cent molybdenum for best creep strength in elevated temperature applications; and 20 to 30 per cent nickel austenitic ductile irons for maximum resistance to corrosion and high temperature oxidations.

Clearly, as in different grades of steel, the wrong grade choice in a particular situation could make ductile iron look very bad.

We are ready to discuss particular applications and problems any time, and so are the ductile iron producer foundries.

A section on welding ductile iron is included in the body of the paper. Suffice it to say that ferritic ductile iron is weldable with some loss of ductility. Hardenability-promoting elements should be minimized, casting surface should be clean, welding amperage should be low, and a ductile iron, coated austenitic rod of the 60 per cent nickel–40 per cent iron composition, or low hydrogen mild steel rod should be used. Maximum machinability is attained by post-annealing.

The cost of ductile iron varies with the type of castings and quantity being made. It varies from 11¢ per lb for the simplest shapes in low overhead foundries, to 20–30¢ per lb average for medium size engineering castings, to 50¢ per lb or even higher for precision-cast specialty items. ▲

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"The Rolling of Ultra Thin Tinplate," by Dr. Morris D. Stone, Manager, Development, United Engineering and Foundry Co., Pittsburgh, Pa.

"Influence of Wear on Pressure and Stress Distribution in Rolls of Four-High Mills," by Dr. Kin Nee Tong, Professor, Dept. of Mechanical Engineering, and J. V. Latorre, Research Engineer, Dept. of Chemical Engineering and Metallurgy, Syracuse University Research Institute, Syracuse, N. Y.

"Developments in Drive Systems and Gage Control for Reversing Cold Mills," by K. A. Petraske and R. M. Sills, Metal Rolling & Processing Engineering, Industrial Engineering Operation, General Electric Co., Schenectady, N. Y.

"The Application of a Non-Contacting Measurement System for Coating Weights on Continuous Galvanizing Lines," by James E. Reider, Area Manager, Industrial Nucleonics Corp., Columbus, Ohio

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"Four-Zone Reheating Furnaces and Pusher Controls," by William A. Greene, Assistant Superintendent, Plant No. 2 Mills, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"Construction and Maintenance of Regenerative Soaking Pits with Plastic Refractories," by F. E. Waterman, Division Superintendent, Primary Rolling Mills, and William H. Kirwan, Superintendent, 43-in. Blooming Mill, Youngstown District, United States Steel Corp., Youngstown, Ohio

"Operational Results of Automatic Gage Control on a Hot Strip Mill," by R. M. Peeples, Supervisory Engineer, and E. H. Christian, Engineer, Control Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

"Simulating Thermal Response in Slab Reheating," by C. G. Bigelow, Director of Research, Selas Corp. of America, Dresher, Pa.

"An Analysis of the Roll Flattening of a Double-Poured Roll," by Dr. Carl F. Zorowski, Assistant Professor of Mechanical Engineering, and Dr. Alvin S. Weinstein, Assistant Professor of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

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Automatic Gage Control on Cold Rolling Mills at DOFASCO

by N. D. STEPHENS
Superintendent Electrical Maintenance
and A. BISCI
Electrical Foreman
Galvanize and Sheet Dept.
Dominion Foundries and Steel, Limited
Hamilton, Ontario, Canada

FOR sometime previous to selecting and purchasing gage control our management had been interested in applying automatic gage control to the cold mills. Customers with higher speed machinery had been demanding closer tolerances and while it is possible on manual control it is a heavy strain on the operators.

After carefully looking over several schemes a combined screwdown and tension regulation control method was selected.

As will be seen later this system of measurement and control uses the roll gap as a measuring device as well as control and does away with the inherent transport time problem of other methods.

The original gage was supplied and installed in the spring of 1957. This mill is a 56 in. wide, 4-high reversing cold mill. Maximum strip speed 3000 fpm, powered by two, 2170-hp motors; each motor direct to the work rolls or through gears to backup roll drives with no mechanical tie between the motors.

The two reels are powered by tandem motors, each reel having a total of 2170 hp. The reels are conventional cemf regulators and generators controlled by 400-cycle magnetic amplifiers into exciter generators.

The reels will supply a tension of from 6000 to 30,000 lb within the nameplate ratings of the motors.

In practice somewhat more tension is used at times but the mill is seldom operated at speeds in excess of 2500 fpm.

The mill was primarily installed to supply cold rolled strip to the galvanizing line but it was realized it would have spare capacity and was built to roll tin plate gages down to 0.006 and up to 50 in. wide. However, it is not possible to roll this width down to the very thin gages.

MEASUREMENT OF GAGE

A rolling mill can be regarded as an elastic structure which obeys Hooke's law, consequently there is at all times during the rolling process a definite relationship between roll force, unloaded roll gap and loaded roll gap. If the elastic recovery of the strip leaving the mill is assumed to be negligible, then the loaded roll gap gives a direct measure of outgoing gage. These facts can be expressed in the form of the following equation which is generally known as the mill equation.

$$\frac{F}{M} + S_0 = h \qquad (1)$$

F = force tending to separate the rolls in tons.
M = elastic constant of the mill in tons per in., hence it is a measure of the mill "spring" and will be dependent on the geometry of the mill housings and rolls.
S_0 = gap between the work rolls in in. when F is equal to zero.
h = outgoing gage in in.

The S_0 signal is obtained from suitable transducers

Combined screwdown and tension regulation control permits rolling to the better tolerances now required, at the same time reducing operator strain.

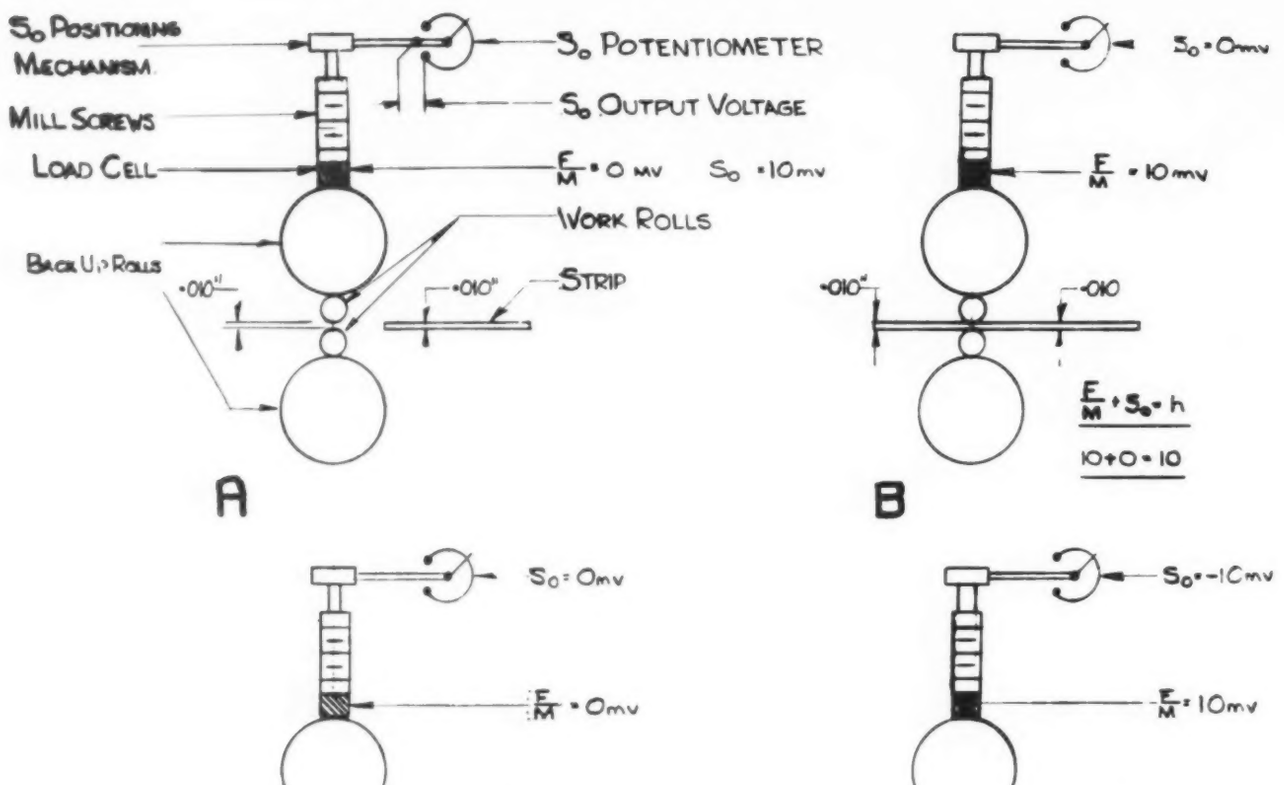


Figure 1 — The roll gap is used as a sensing device to control gage correction.

driven from each of the mill screws. The outputs from these transducers are added and fed into a follow up servo which drives a precision potentiometer. The output voltage from this potentiometer is therefore proportional to the unloaded roll opening. Load cells are mounted under the mill screws to give a signal proportional to F/M. In principle the automatic gage control consists of the necessary electronic equipment for combining these signals in accordance with the mill equation to produce a further signal which is proportional to the outgoing strip thickness.

The mechanism of automatic gage control based on the mill equation is best illustrated by the following specific cases.

Case one—Let it be supposed that the unloaded roll opening is set at 0.01 in. as shown in Figure 1A and also that the S_0 potentiometer circuit is so designed that 0.001 in. corresponds to one mv. In the absence of the strip the F/M signal under these conditions will be zero. On introducing a strip of 0.01 in. thickness into the mill, F/M will remain at zero since no reduction is achieved under these conditions. If the screws are now lowered 0.01 in. the value of S_0 will become zero. In this case it is assumed that the strip is infinitely hard and therefore the actual roll gap will remain unchanged at 0.01 in. as is shown in Figure 1B. Evidently the mill has now been stretched by 0.01 in. The resulting force produces an output from the load cell of ten mv. Similarly if this reasoning is applied to the case where S_0 is adjusted to 0.02 in., the strip thickness is 0.02 in. and the screws lowered 0.02 in. the output from the load cell will be 20 mv, if the mill modulus M is constant (i.e., the change in load per unit change is S_0). In practice the mill modulus is substantially constant for the loads encountered in normal rolling. It will be noted that in the two cases considered the sum of the F/M and S_0 signals is equivalent to strip thickness where one mv corresponds to 0.001 in. of strip.

Case two—If the rolls are just touching, i.e., $S_0 = 0$ as in Figure 1C lowering the screws 0.01 in. will produce an output from the load cells of ten mv. The value of S_0 now becomes minus ten mv as shown in Figure 1D. This negative value corresponds to the preloaded condition which occurs in practice during the rolling of lighter gages. It is apparent in this case that the sum of S_0 and F/M will be zero regardless of how far the screws are lowered. This means that under preloaded conditions with no strip in the mill the S_0 voltage produced will be exactly cancelled by the corresponding F/M voltage. This is in accordance with the mill equation for the case where h is equal to zero. Operating the mill in this manner provides a convenient method of checking the calibration of the gage control equipment.

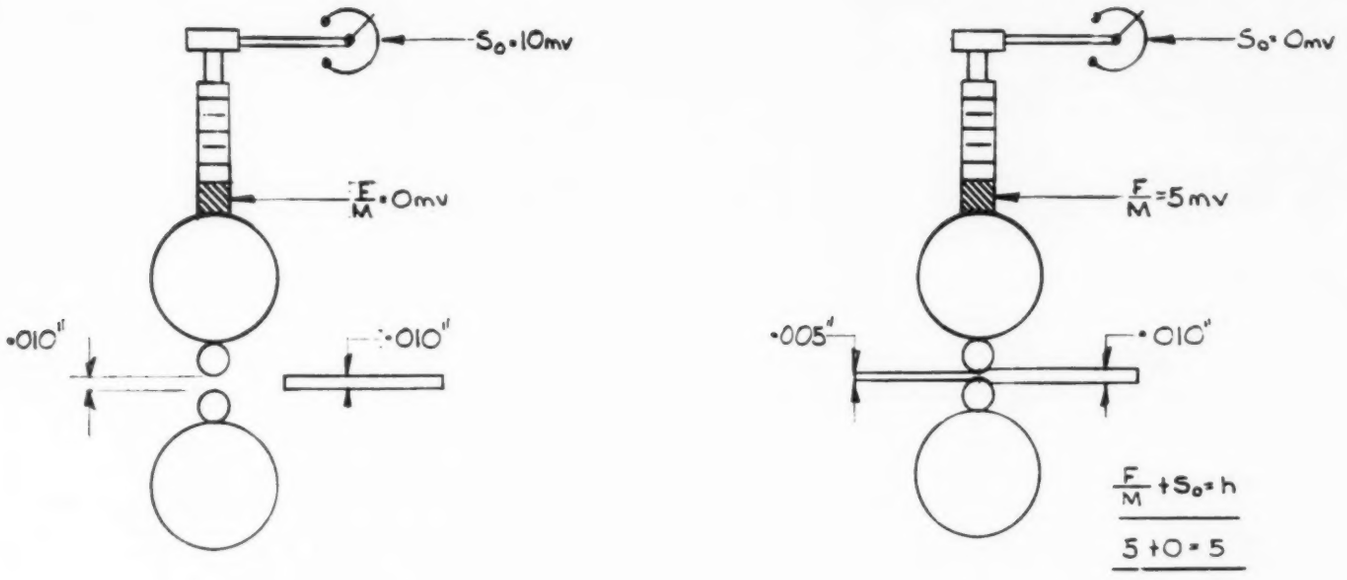


Figure 2 — When reduction takes place the change in the S_0 signal is greater than the change in the load signal F/M.

Case three—If the physical properties of the strip are such that lowering the screws by 0.001 in. reduces the output gage by 0.0005 in. then the ratio of gage change to screw movement is 0.5. This ratio may be referred to as the "roll gap transfer ratio." Considering Case one where instead of using an infinitely hard strip (i.e., the roll gap transfer ratio is zero), a 0.010-in. strip is used with a transfer ratio of 0.5 as shown in Figure 2, then a 0.010 in. movement of the screws will reduce the thickness by 0.005 in. Under these conditions the mill would have stretched by 0.005 in. with a corresponding output from the load cells of five mv. The S_0 signal would be zero and the sum of this and the F/M signal would be five mv corresponding to the strip thickness of 0.005 in. It follows from this that when reduction takes place, the change in S_0 signal is greater than the change in the load signal F/M.

AUTOMATIC GAGE CONTROL

The analysis of the mill equation shows that an accurate measurement of gage can be obtained by suitably combining signals proportional to roll force and screw position. This technique may be used to provide an automatic gage control. The quantity $F/M + S_0 = h$ is compared with a reference signal and the error or difference is then fed through appropriate amplifiers to the screwdown regulators. The mill equation now becomes:

$$\frac{F}{M} + S_0 - h' = \Delta h \qquad (2)$$

where h' is the reference gage setting and Δh the gage error (i.e., the difference between the actual gage h and the desired gage h') in in. Both of these quantities will be represented electrically and by way of example it will be supposed that as before 0.001 in. corresponds to one mv.

Considering the case shown in Figure 3 where the unloaded roll gap setting is 0.050 in. (50 mv), the reference setting h' is set at 0.050 in. (50 mv) and F/M

Figure 3 — The roll gap transfer ratio varies from coil to coil; however, gage control is possible providing the ratio value is above zero.

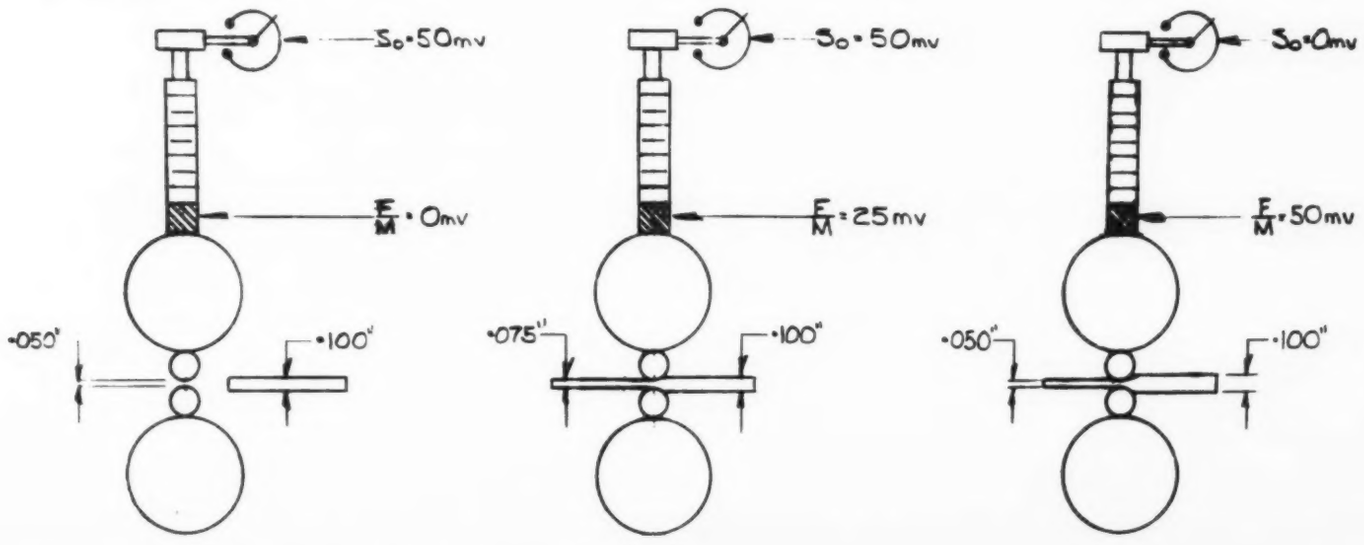


TABLE I

Incoming thickness, in.	Transfer ratio	F/M	S_0	h′	Δh	Outgoing thickness, in.
0	0	0	50	50	0	0
0.100	0.5	25	50	50	+25	0.075
0.100	0.5	50	0	50	0	0.050

is zero, then substituting in equation (2).

$$0 + 50 - 50 = 0$$

Therefore the gage error is zero.

Supposing a strip 0.100 in. thick with a roll gap transfer ratio of 0.5 is loaded into the mill then referring to Table I it will be noted that the outgoing gage will be 0.075 in. and the gage error is equal to 25 mv or +0.025 in. The error signal is fed through amplifiers to the screwdown regulators which force the work rolls down on the strip. Since the mill transfer ratio is 0.5 and the gage error is 0.025 in., the screws must move from 0.050 in. to reduce the strip to the required thickness when Δh will become zero. The roll gap transfer ratio varies from pass to pass and coil to coil, but providing that it is above zero the gage may be controlled. It is well known that gage may be controlled on a mill by varying back and front tensions and this fact is made use of in the automatic gage control system by feeding the gage error signal through amplifiers to the tension regulators.

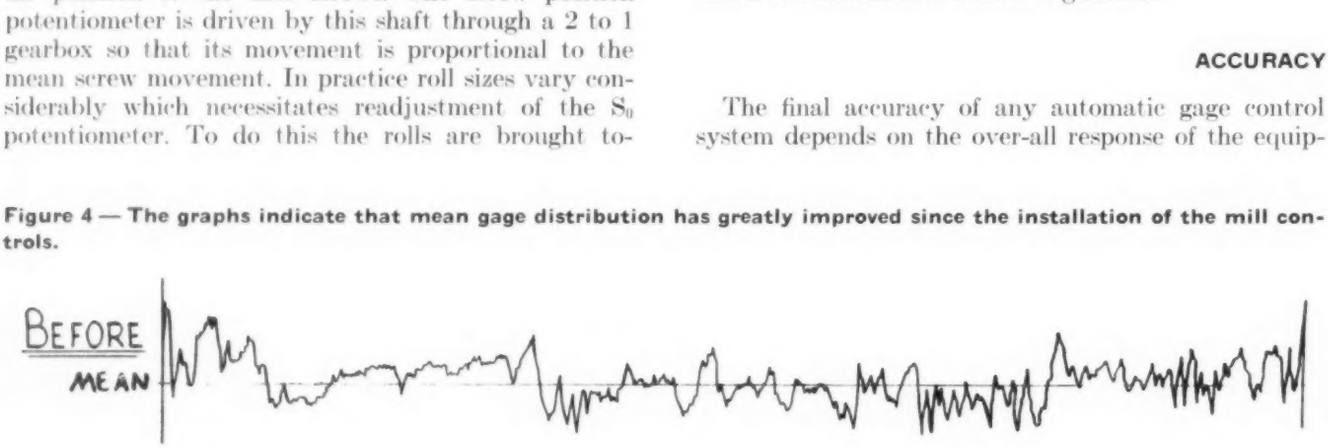
DESCRIPTION OF THE SYSTEM

Synchros driven by the mill screws are used in conjunction with a follow up servo to provide a shaft whose angular position is proportional to the sum of the angular position of the mill screws. The screw position potentiometer is driven by this shaft through a 2 to 1 gearbox so that its movement is proportional to the mean screw movement. In practice roll sizes vary considerably which necessitates readjustment of the S_0 potentiometer. To do this the rolls are brought together at a definite roll force when a "re-zero" button is pressed which allows the servo motor to drive the S_0 potentiometer independently from the position synchros. The motor stops when the S_0 voltage exactly cancels the F/M voltage and under these conditions the equipment is properly calibrated in accordance with the mill equation. The outputs from the load cells are summed in a mixing transformer to provide a signal proportional to roll force. The F/M, S_0 and h′ signals are combined in accordance with equation (2) to produce an output which is proportional to the gage error h. After power amplification this signal drives a servo motor. A linear synchro is coupled on to the servo motor shaft to provide the primary feedback signal to the summing amplifier in a null balance system. A pointer is fastened to the same shaft to give an indication of the gage deviation Δh. The linear synchro feeds a signal into phase sensitive detectors and power amplifiers to supply signals at an appropriate level for controlling the magnetic amplifier tension and screwdown regulators. In order to avoid unnecessary operation of the screws on the heavier gages, deadband or gate settings are provided which are controlled from a switch calibrated in 0.001, 0.0005, 0.0003 and 0-in. steps. The screws therefore are inoperative when the gage deviation meter is within the gate settings. The system is set up so that a gage deviation of 0.001 in. produces a screwing speed of 0.004 in. per sec. The tension control is not gated and operates continuously. The gain of the tension control is such that a gage deviation of 0.001 in. produces a change corresponding to 10 per cent of full tension. It was found in practice that automatic gage control using screwdown control only was rather slow and attempts to hold the gage deviation to zero on lighter passes resulted in excessive screw movement. This difficulty was overcome by using combined screwdown and tension regulation.

ACCURACY

The final accuracy of any automatic gage control system depends on the over-all response of the equip-

Figure 4 — The graphs indicate that mean gage distribution has greatly improved since the installation of the mill controls.



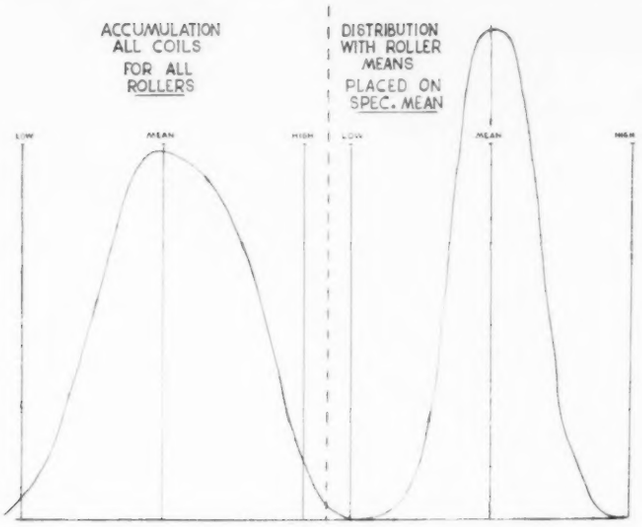


Figure 5 — Gage variation within a coil has been reduced and is indicated by customer inspection reports.

ment, and the accuracy of the gage measurement. The following are some of the factors affecting the measurement of gage using this particular system.

Temperature effects—The housing, backup and work rolls expand and contract with changes in temperature. This will cause a change in the S_0 signal which cannot be detected by the screw position measuring system. This effect can be minimized either by periodic rezeroing of the mill, or by using a monitoring gage for the automatic control. Monitoring is achieved by comparing the deviation signal from the automatic control with the deviation signal from the flying micrometer and feeding the difference into an integrating servo. The integrated difference signal is fed to the summing amplifier in an appropriate direction to bring the gage deviation signal into correspondence with the monitoring gage. The maximum speed of correction is approximately 0.00025 in. per sec. Temperature changes in the mill take place slowly, consequently a slow response monitor performs satisfactorily.

Oil film—There is a change in the thickness of the oil film in the backup roll bearings which produces an error in the S_0 signal with changing mill speed. A speed dependent correcting signal is fed into the summing amplifier to compensate for this condition.

Compensating for this inaccuracy with the monitor is undesirable as it necessitates a comparatively fast response.

Non-linearity—In practice it is found that the mill modulus is apparently not constant at low mill loads and extremely high mill loads. The curvature at the low end is at a point well below normal rolling pressures. If necessary, this effect can be corrected by feeding an additional signal to the summing amplifier which varies with load.

Roll eccentricity—Eccentric rolls will cause a variation in the S_0 signal which the gage controller interprets as a gage error signal. Normal roll grinding procedures are such that satisfactory operation can be obtained from the system, although there is no doubt that roll eccentricity is a major factor in limiting the performance. At the time of writing, experimental work is being done on a device for minimizing the effects of roll eccentricity ripple.

SUMMARY

The gage just described has worked out very well on our 56-in. mill which is the only mill so equipped to date. It is not an absolute measuring device and early experience pointed this out, as illustrated by Figure 4 showing accumulation of gage distribution for all coils for all rollers, and what could be achieved if all the individual characteristic mean were set on the specific mean or target.

It is now possible to control the gage deviation and this triggered a program for better maintenance and control over the monitor gages.

The results of this are shown by customers' incoming inspection ratings before and after automatic gage control. A chart from the mill monitor is illustrated by Figure 5 which is more or less typical of "before" and "after" results.

Discussion

PRESENTED BY

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Hatboro, Pa.

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Dominion Foundries and Steel, Ltd.,
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Cleveland, Ohio

J. I. BEGGS, Systems Application Engineering,
Canadian General Electric Co., Ltd.,
Peterborough, Ontario, Canada

T. W. Roberts, Jr.: We would be interested in Mr. Stephens comments as to the use of electro-hydraulic actuation in the system for positioning the mill screws in place of or as a dynamic adjunct to the electric screwdown motors. The delay or time constant of an electro-hydraulic valve and actuator will be significantly less than a comparable electric motor. Additionally, a hydraulic positioning system is capable of delivering essentially maximum torque when stalled; a feature which is extremely advantageous in this application.

N. D. Stephens: Mr. Roberts' idea is not entirely original. The idea is good; we would like to see somebody try it.

Member: The unique feature of this method of automatic gage control, of course, stems from the fact that with a roll force measurement being made it is intended then that an error can be noted right at the roll bite; however, considerable compensation for roll eccentricity, oil film change in the bearings and temperature changes must be made. The over-all system has to be a good combination of reasoning from both

the mechanical and electrical standpoint for if signals of the type given by roll eccentricity are filtered out, then the delays introduced may be equal to or even greater than those transport time delays which might be found in an x-ray gage system where the gage giving an absolute measure of thickness is measured following the roll stand.

We would very much like to know to what extent such things as roll eccentricity were taken into account and how data were collected for oil film change and speed changes giving rise to some of these signal differences that you expect.

A. Bisci: The thickness of the oil film varies with mill speed but does not change appreciably with the rolling load. With our system of gage measurement it is a relatively simple matter to determine the magnitude of the change in oil film thickness.

To do this the mill is run at thread speed with no strip between the rolls and the gage control is re-zeroed. Having completed this operation the mill speed is then increased in small steps. During each of these steps the apparent gage error is reduced to zero by adjusting the gage reference decade switches. The difference between successive readings of the decades will therefore give a measure of the change in thickness of the oil film. To compensate for this a signal dependent upon mill speed is generated and fed into the summing amplifier.

Member: How frequently in bringing up a cold mill do you have to go through the zeroing procedure?

A. Bisci: The gage controller must be re-zeroed after each roll change.

Member: Does it take into account roll wear?

A. Bisci: If roll wear occurred during the rolling process there would be an error in the S_0 signal. To overcome this the gage controller would have to be re-zeroed.

Member: The fact that the diameter of the work rolls is being diminished might affect your M constant. Is this a factor?

A. Bisci: This is the whole criterion for this method. You can screw down to a certain point; after that it is linear. You see you can run the mill empty, and bring the rolls together to a definite roll force. The examples we used are not 100 per cent true in this sense. The reason we said "when the rolls were just touching" was for the purpose of clarity. In fact, the mill does not linearize until you get up to, in our case, 500,000 lb per screw. This is well below the normal rolling pressures. After that, if you keep screwing the mill down, the gage meter stays on zero. This means that the M line is linear so any given gage change will produce a linear output from the load cells.

I. G. Orellana: In this system of control use is made of the screwdowns to give a correction as indicated by the gage meters. Would you care to comment as to whether you require constant potential screwdowns or Ward Leonard control screwdowns?

N. D. Stephens: In this particular application, we have a variable potential screwdown control, but we are in the process of applying it to the present potential regulator system. We cannot say how that will work as yet, but the manufacturers assure us it will approach the performance of the other type.

H. Maxwell: The results at Dofasco are of great interest because the installation described is the first North American installation of this type of thickness regulating system. We are enthusiastic regarding such systems. Our company, including our Canadian company, is presently building systems of this type for both hot and cold strip mills.

What is the authors' estimate of the roll gap transfer ratio mentioned when finishing 8 or 10-mil strip for tinplate? Do the screws actually make the full excursions required to imprint the full value of backup roll eccentricity?

For instance, assuming eccentricity of each backup roll is one mil peak to peak, as measured by dial indicator, the eccentricities of both can produce a two mil change in thickness. If the transfer ratio is 0.5 the screws will move four mils. If the ratio is 0.2 the screws will move ten mils. A full cycle of screw travel is required for each revolution of the backup rolls. Perhaps, at running speed, the screws do not actually make the full excursions required, in which case the adverse effect of roll eccentricity may be reduced.

What is the estimated total change in oil film thickness for both top and bottom backup rolls as the mill accelerates?

A. Bisci: The transfer ratio for 8 or 10-mil strip for tinplate varies between 0.0 and 0.5. The screws are not sufficiently fast to imprint the full value of roll eccentricity. The total change in oil film thickness is approximately six mils from 0 to 2000 fpm.

E. E. Vonada: What is the percentage of tension change employed from the payoff reel? On changing gage do the limits on the tension vary?

A. Bisci: The tension controller saturates with one mil gage error. This will produce a change of 10 per cent of the maximum run tension. This is a maximum limit and does not vary with the operator's reference setting.

E. E. Vonada: Is that a maximum limit?

A. Bisci: That is right. It does not vary with the operator's setting. The operator can set his reference wherever he wants, the amount of tension change with gage deviations will still be the same. We thought at first we might have to vary it with the reference setting, but it worked all right.

J. I. Beggs: We have done considerable analytical work on this form of automatic gage control over the past year. Results of these studies would indicate that higher gains than those mentioned in the paper might be possible in both screw and tension regulators. Have higher values of gain been attempted and, if so, are there considerations which would make higher gains inadvisable?

Mention is made of an error due to oil thickness variations with changing mill speeds. Has there been any variation in the amount of correction necessary at any given strip speed? Is it possible that the monitor could be used to provide correction for this variation?

A. Bisci: Due to the wide variety of products rolled on this mill we have found that a screwing speed of four mils per sec for a one mil gage error gave the best results. The error due to the change in oil film thickness is consistent.

A fast response monitor would be required to provide correction for this variation, which would re-introduce the transport delay problem. ▲

THE HYDROELECTRIC CRANE

by W. A. MOREY, Vice President, Whiting Corp., Harvey, Ill.

Talk presented before the Seventh Biennial Materials Handling Conference, Pittsburgh, Pa., October 20, 1960

THE hydroelectric crane has evolved directly from a study of overhead traveling crane users' problems and needs. During this study, various needed improvements were discussed with crane users and their operations were observed and some very carefully compiled maintenance records covering many cranes of all makes operating for extended periods of time under reasonably heavy service were reviewed.

From this study, it was found that perhaps one-half of the crane service calls were electrical in nature and, of the remainder, a heavy majority related to brakes. While the investigation also disclosed some need for precision control, a more general and important requirement was the need for greater speed in order to obtain improved crane utilization.

These general findings, plus one or two others provided the design objectives for a new crane. In brief, these objectives were:

1. Safety—No compromise permitted with safety. The crane must fail safe under all conditions.

2. Control—Stepless control is desired with sufficient range to handle all probable conditions and to increase the crane's capacity for performing work by the use of higher top speeds. Very slow speed of the hook should be available when lowering a maximum load without special shifting or adjustment of the control. A desired minimum speed ratio is approximately 200 to 1.

3. Maintenance—Both the amount and quality of maintenance required are to be drastically reduced. Particular attention is to be given to a reduction in electrical and brake maintenance. Simplification is desired to permit maintenance by relatively unskilled help.

4. Price—A modest premium will be permitted if justified by improved performance and low maintenance.

After considerable debate and some trial, it was decided to use a positive displacement hydraulic drive. There were several reasons for this choice. For example, our company has for years employed a hydrostatic drive to regulate the arc length and therefore the power delivered to steel melting furnaces. These drives react with almost unbelievable accuracy and speed, operating continuously under severe and adverse operating conditions. This is reasonably conclusive proof that a properly designed hydraulic system can be a durable and satisfactory power transmission device. This proof is confirmed by hydraulic systems in every day use, such as those employed on construction equipment, fork lift trucks, machine tools and some of the more exotic missiles. Another highly persuasive reason for electing hydraulic drive is the ability of a hydraulic motor to resist movement of an overrunning load when the motor outlet is restricted or blocked. This ability provides a frictionless brake which wastes the necessary amount of energy by producing heat in the oil which can be easily cooled by passing through a radiator.

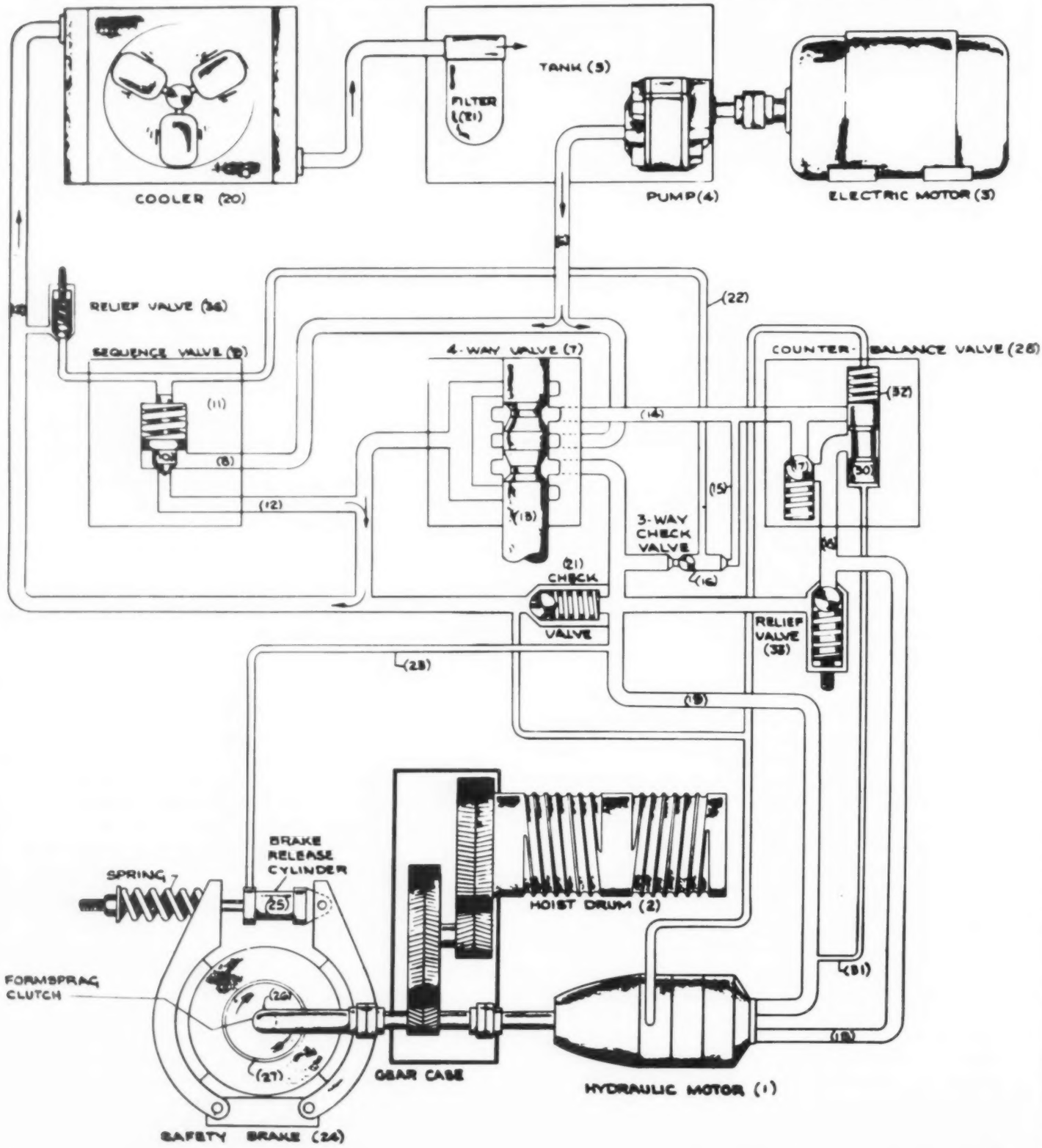
Since the trolley frame, axles, bearings, gear train, drums and similar components all seemed to be reasonably free of maintenance, the basic structure was preserved, including the present double reduction hoist gear train. However, the mechanical load brake was discarded. Figure 1 shows a brake drum and a positive displacement hydraulic motor coupled directly to the hoist gear box pinion. To obtain minimum internal leakage and maximum wear, these motors are either the piston or the vane type, usually with splined output shafts. The friction brake around the brake drum is applied by an unusually long spring. By the time about one-third of the brake lining is worn away, the spring force available to set the brake is still sufficient to give the brake about 150 per cent holding capacity. Brake release is accomplished by actuating the hydraulic cylinder which obtains pressure fluid from one of the lines leading to the hydraulic motor, similar to the manner in which a conventional solenoid hoist brake obtains its power from the motor leads.

This alone would eliminate a great many otherwise necessary hoist brake adjustments. However, the brake

life is even more greatly extended than one might imagine, because the hydraulic system brings the load virtually to a stop before the hoist brake is applied. In essence, the function of this hoist brake in ordinary operation is merely to hold the load motionless after it has been brought to a stop by the hydraulic system. The heat usually generated in a friction brake on a crane hoist is not developed in this hydraulically actuated brake but rather appears in the hydraulic fluid and is easily dissipated by passing the heated oil through a full-flow thermostatically controlled heat exchanger.

Positive displacement pumps on the trolley provide pressure fluid for each of the trolley motions and are driven by a single squirrel cage motor which runs in one direction only. These pumps share a common tank, cooler and filter. An exceptionally good motor was developed for driving hydraulic pumps since it incorporated the spline for the pump shaft directly in the

Figure 1 — General arrangement of the necessary hydraulic hoist equipment indicates the simplicity attainable.



motor shaft, eliminating need for a coupling. This is associated with a heavy, accurately machined end bell which holds the pump in absolute alinement with the shaft. The compact nature of this assembly saves considerable room and greatly simplifies the problem of changing the pump when necessary. If the crane is in reasonably steady use, most users allow the trolley drive and hoist motor, and the bridge motor to run continuously.

Since only two squirrel cage motors are required for a crane having a single trolley, it seems clear that the electrical components will be simple and few in number. The crane requires starters for the two motors, a master switch, a lighting transformer and switch, and only three pickup wires on the crane bridge and runway. Electrical maintenance is reduced to a minimum in such a system. Motor burnout seems very unlikely because the squirrel cage motor runs continuously in one direction at its basic speed. The high current surges ordinarily associated with the frequent starting and reversing of a crane motor, with their attendant heating effect on the motor, are eliminated and proper setting of the hydraulic relief valve makes serious overloading of the motor or crane virtually impossible.

Operation of the hydraulic hoist system is illustrated in Figure 1. A positive displacement pump No. 4, driven by the electric motor No. 3, continuously drives a fixed volume of oil through the pipe No. 6 which is connected both to the inlet port of a four-way directional valve No. 7 and to a sequence valve No. 9. When the four-way valve is in neutral position, its inlet port is blocked and all of the oil will therefore pass to the sequence valve. This valve has a plunger No. 10 normally biased toward a closed position by a spring No. 11 arranged on the side of the valve opposite the valve exhaust port. This spring is quite light and is easily lifted by the oil from the pump at approximately 30 psi, thus allowing oil to escape through the discharge pipe No. 12 to the cooler No. 20, the filter No. 21 and the tank No. 5.

When lifting a load, the spool No. 13 of the four-way valve No. 7 is moved downwardly, allowing oil to pass from the inlet port of the valve to the pipe No. 14 across an orifice formed by movement of the spool No. 13. This oil travels through check valve No. 17 and pipe No. 18 to the hydraulic motor No. 1 which is connected to the hoisting drum No. 2 through a suitable gear train. The oil is still under relatively low pressure, such as 30 psi, and, therefore, unable to drive the hydraulic motor and lift the load. However, note that pipe No. 14 also is connected by pipe No. 15 to a shuttle valve No. 16 which, urged by the oil, moves to the left and allows oil at approximately 30 psi to enter the sequence valve through line No. 22 and supplement the valve closing force of the spring. This raises the pressure system in a very small fraction of a second sufficiently to drive the hydraulic motor No. 1 and lift the load. Oil passing through the motor returns to the four-way valve through the pipe No. 19 and is discharged to the cooler No. 20.

This system will develop only enough pressure to safely obey the commands of the operator, never any more, and this is true regardless of whether there is an empty hook or maximum load on the hoist drum. In other words, the speed of the hook for any given position of the operator's control handle is virtually a constant

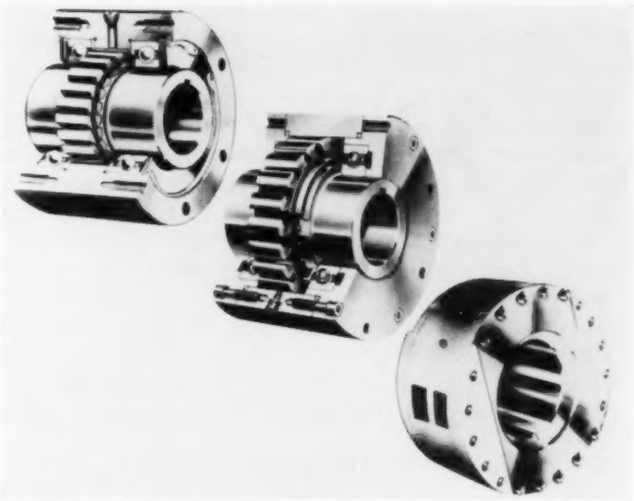


Figure 2 — The internal arrangement operates in races of bearing quality steel.

under all conditions. The reason is that the four-way valve, as it is opened, forms an orifice, and as flow occurs across this orifice when the hydraulic motor starts to turn, a pressure drop occurs. The pressure downstream from this orifice is the pressure which supplements the pressure of the spring in the sequence valve No. 9. Thus, the upstream pressure in the pipe No. 6 will exceed the pressure downstream of the orifice in the pipe No. 14 only by the pressure of the spring No. 11 in the sequence valve. If the pressure drop across a given orifice is held constant, as is the case here, then the flow of oil through that orifice will vary directly only with the cross-sectional area of the orifice. Thus the size of the orifice produced by moving the four-way valve determines the speed, and the pressure is automatically increased by the system to whatever degree necessary to obtain the speed dictated by the position of the operator's control handle.

The brake No. 24 is mounted on the pinion shaft of the hoist gear box and remains closed under the pressure of the spring during the hoisting operation. Movement is permitted by mounting on the pinion shaft a one-way clutch which allows the hoist pinion to turn in the hoisting direction only. Thus, unless hydraulic pressure builds up sufficiently to lift the load, it will be held against lowering by the brake No. 24. Figure 2 shows the internal arrangement.

To lower a load, Figure 1, the spool No. 13 is moved upwardly, forming an orifice between the pressure inlet port and the pipe No. 19. By reversing the flow of oil, the motor No. 1 will be driven in the opposite direction but cannot turn until the brake No. 24 is released by actuation of the hydraulic cylinder No. 25. This will occur only when a predetermined pressure, say 150 psi, is developed or exceeded in the pipe No. 19. As the brake opens, oil flows through the motor into the pipe No. 18 but is prevented from returning to the tank by the check valve No. 17 and the counterbalance valve No. 28, which is a balanced valve biased by a spring No. 23 to a closed position. This valve is moved toward an open position by pressure in the pipe No. 19 in a manner similar to the opening of the brake, but in this case a higher pressure is required. As the counterbalance valve opens, it forms an orifice through which oil discharged by the hydraulic motor is metered.

The pressure developed in the line No. 18 is equal to the pressure developed by the load which is driving the hydraulic motor and the pressure in the inlet pipe No. 19. If the load tries to move downward at a rate greater than oil is being supplied through the four-way valve to the pipe No. 19, the motor draws sufficient oil from the pipe No. 19 to reduce the pressure which, in turn, allows the counterbalance valve to move toward closed position, thus throttling the rate of load movement. The counterbalance valve therefore is the load brake of this system. Oil discharged from the counterbalance valve passes through pipe No. 14 and through the four-way valve to the cooler. Note however that if the four-way valve is moved to neutral position, this return flow through the pipe No. 14 to the cooler cannot occur.

It is necessary to drive the load downward with hydraulic pressure. If for any reason hydraulic pressure in the line No. 19 should fail, the counterbalance valve will not open or if already open will close by action of spring No. 32 and thus block discharge of oil from the motor. Furthermore, if the four-way valve is moved by the operator to a neutral position, it will block discharge of the oil through the pipe No. 18. Loss of pressure in the line No. 19 also causes the brake No. 24 to set, retarding or stopping the load.

There are two relief valves in the system. One is located in the sequence valve communicating with pressure line No. 22. If the operator attempts to lift a load too heavy for the crane, the pressure builds up only to the setting of the relief valve but no further. Thus, this relief valve limits the lifting force developed by the crane and, thereby, protects both the hydraulic system and the crane against overload.

The other relief valve No. 33 is set at a somewhat higher pressure and opens only under certain conditions. This occurs when the operator rapidly lowers a heavy load and suddenly moves the control handle to neutral. This causes the counterbalance valve to close and also blocks discharge from the line No. 14. Under these conditions, severe shock could occur, but instead the relief valve No. 33 opens, allowing oil to bleed through the relief valve, through pipe No. 18 to pipe No. 19, absorbing the shock. In effect, therefore, this second relief valve provides a controlled rate of deceleration.

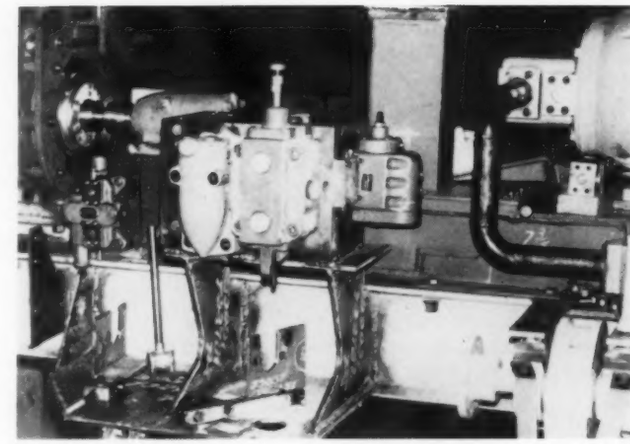


Figure 3 — All the hydraulic control equipment is bolted to a ground steel block manifold.

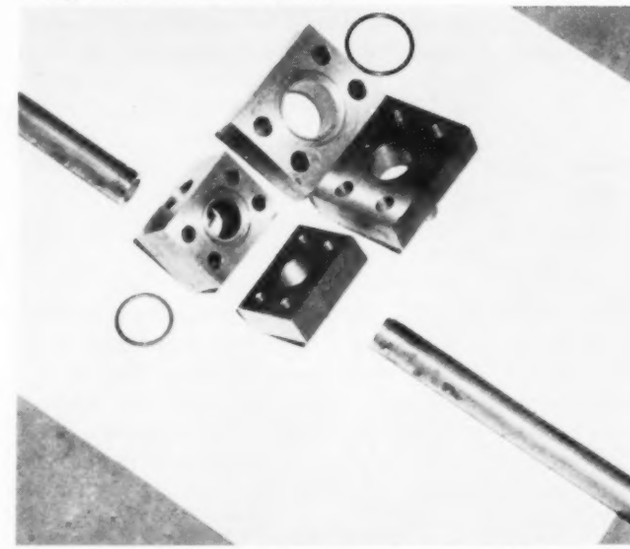
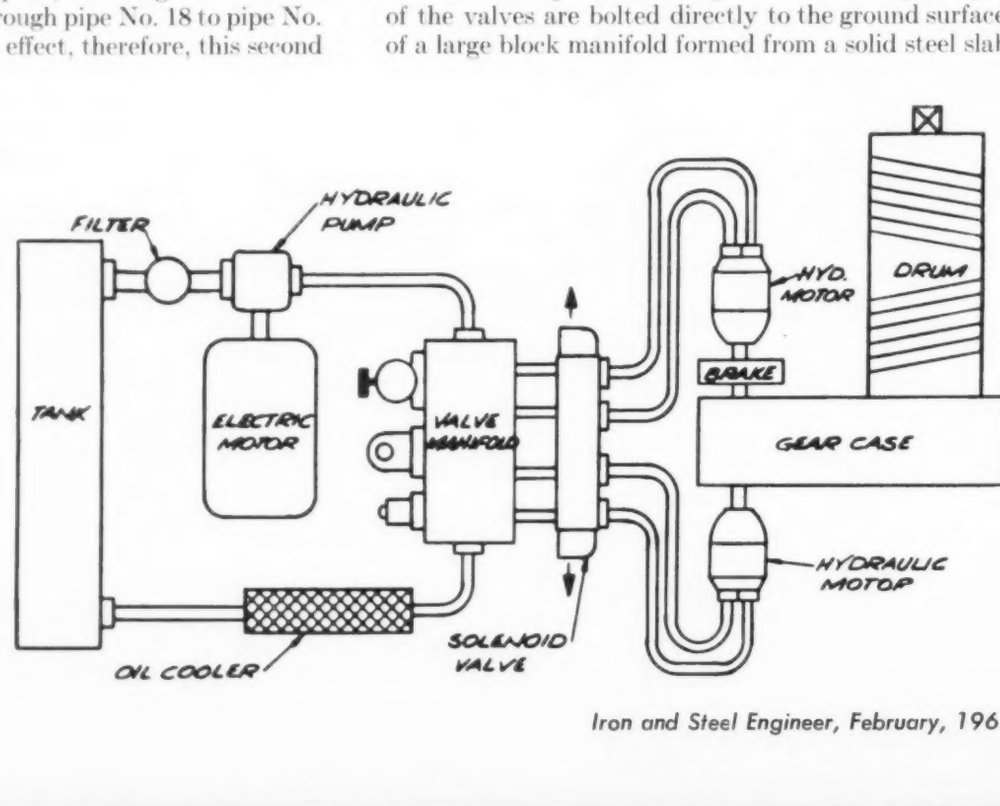


Figure 4 — Fabricated piping uses heavy welded flanges and O-ring seals.

A great deal of attention has been given to the elimination of possible leakage. As seen in Figure 3, all of the valves are bolted directly to the ground surfaces of a large block manifold formed from a solid steel slab.

Figure 5 — Two speed circuits permit faster hook travel at light loads.



All piping, with the exception of some small drain lines, is fabricated with heavy welded flange connections, Figure 4, held together with cap screws and sealed by O-rings. There are no threaded connections in the pressure system. This not only eliminates piping leaks, but also permits the changing of any component in the system with simple tools in a short time.

In many operations, it is desirable to have the crane hook travel at a high speed when handling light loads, and at a slow speed when handling heavy loads. This is easily accomplished by using two hydraulic motors to drive the hoist and by inserting a solenoid valve in the hydraulic lines to switch the hydraulic motors between hydraulic series and hydraulic parallel, Figure 5.

For example, in a recently built crane the hook under 5-ton load moves 100 fpm and under 10-ton load moves 50 fpm. At the 100 fpm speed with 5-ton capacity, the oil passes first through one hydraulic motor and then through the other. By pushing a button in the cab, the valve is thrown to its opposite position where the oil from the pump divides between each motor. Thus, only half the gallonage flows through each of the motors, but each motor is subjected to a full pressure and therefore develops full torque. Therefore, the speed of the hook is 50 fpm rather than 100 fpm, but the capacity is doubled. The operator usually puts the crane in high speed or series position and operates this way with full stepless control from 0 to 100 fpm until he encounters a load that the crane will not lift. Then he simply presses the button in the cab which throws the valve, lifts the load and returns to the high speed position.

The positioning of each of the directional and speed control valves on the trolley is accomplished mechanically. Figure 6 illustrates diagrammatically a system using a continuous run of flexible aircraft control cable about one eighth in. in diameter strung along the bridge and trained over a sheave in the cab. A clamp holds the cable to this sheave while the free ends are secured to a tensioning spring, dividing the cable into upper and lower runs. A bracket carried by the crane trolley has a pivoted arm with a pulley on each end and a link connecting the pivoted arm with the valve. The upper run of the cable is led across an idler pulley, over the pulley on the left end of the pivoted arm and back around another idler pulley mounted on the bracket. The lower run of cable is similarly looped over the pulley on the right-hand end of the pivoted arm. When the operator moves the control handle in the cab to the left, he shortens the upper run of cable and simultaneously lengthens the lower run of cable an equal amount. This forces the pivoted arm to turn counterclockwise and thus operates the valve. Moving the control handle in the reverse direction reverses movement of the pivoted arm.

This particular reeving is quite well adapted to its purpose, because deflection of the crane girder or movement of the trolley on its rails will not produce movement of the pivoted arm or valve. Neither is the control particularly sensitive to tension in the cable runs. This mechanical control system has been in operation on several cranes for a substantial period of time under adverse conditions and has proved highly satisfactory and durable. Its condition can be determined at a glance and it is arranged along the walkway side of the bridge girders so that inspection is a simple matter.

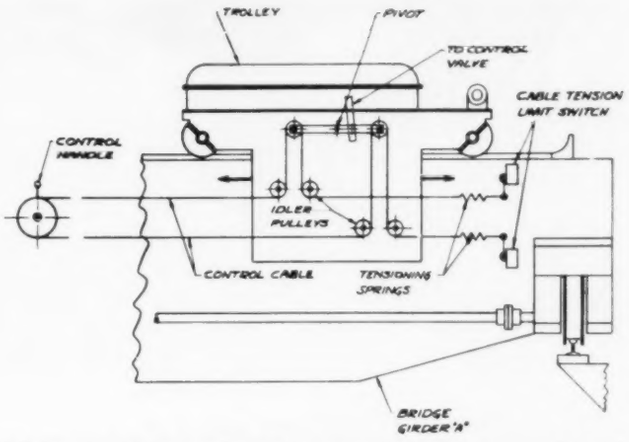


Figure 6 — Valve positioning is controlled by a double run cable system incorporating safety switches to interrupt the motor circuit in case of cable failure.

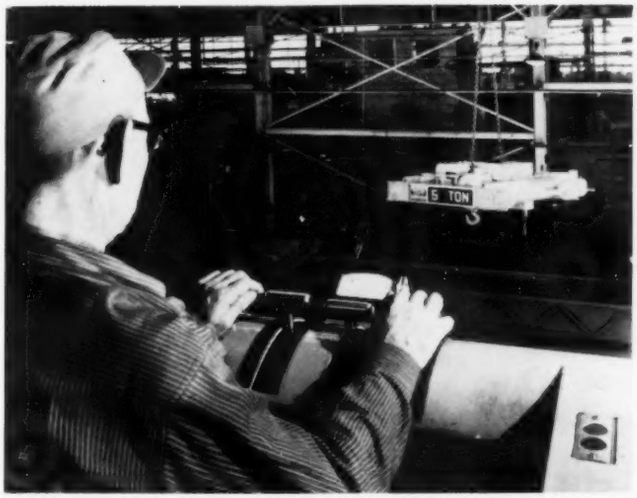


Figure 7 — Compactness of the control members permits construction of a narrow cab with excellent visibility.

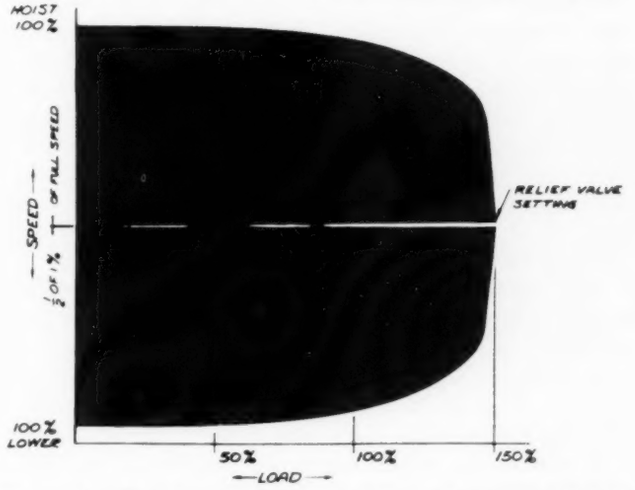


Figure 8 — Positioning of heavy loads can be accomplished with excellent control.

Switches mounted near the tensioning springs are held open by the tension in the cable. Should the cable break, one of the switches will close and interrupt the electrical circuit to the motor, thus bringing all motion to a stop.

The hydraulic circuits used to drive the trolley and bridge motions are considerably simpler than that described for the hoist because the need for precision is considerably less. Each of these motions uses positive

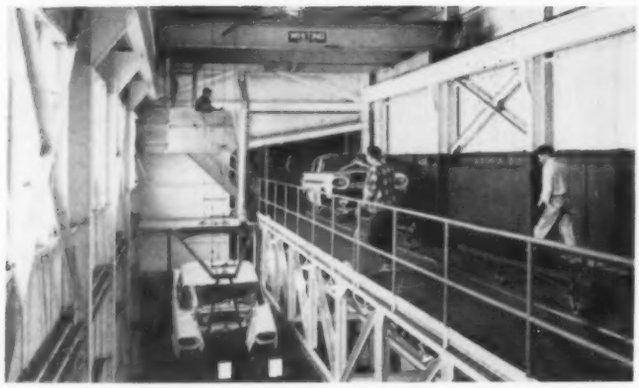


Figure 9 — Accurate control permits this crane to match speeds with the conveyor.

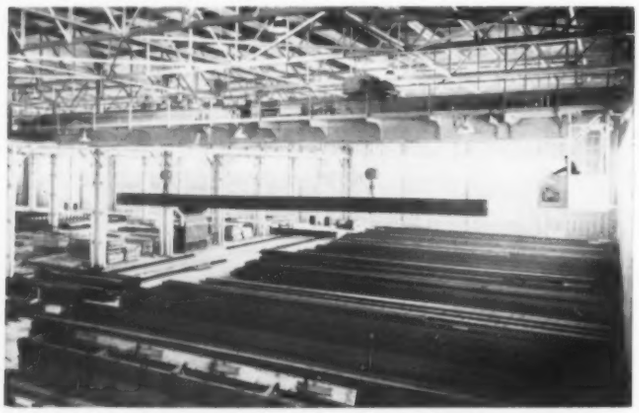


Figure 10 — The two-speed, hydraulic hoist permits accurate positioning in combination with speed and flexibility.

displacement pumps and motors and the necessary relief valves, but control is attained through a single-open-center, four-way valve. In each instance, however, a full-flow cooler and continuous filtration are employed. The controls are designed to operate in a manner basically similar to conventional electrical controls, which minimizes operator training. In other words, if the bridge or trolley is in motion and the control handle is moved to neutral, the bridge or trolley will coast until it is brought to a stop. Plugging is ordinarily employed to control these motions and can be used extensively without endangering the system in any way. The conventional hydraulic foot brake, actuated from the cab, is employed on the bridge drive primarily for holding the bridge in a fixed position when desired.

The cab for this crane, fortunately, can be made quite narrow due in part to the compactness of the control members in the cab, Figure 7. As a result, the operator sees virtually all of the floor from a sitting position if he desires. Also, all of the electrical components, such as the starters, lighting transformer, switches and the like, can be mounted in the cab rather than on the bridge.

Speed ratios of 200 to 1, Figure 8, are easily attained and are effective throughout the entire range of hook capacity.

If the load increases beyond 100 per cent, there is a slight reduction in this ratio because internal leakage of the components increases as the pressure increases. The change, however, is minor. This curve shows that extremely good control is obtained when needed most. A maximum load or overload can be raised or lowered at speeds which frequently are so slow that they are almost a nuisance to the man on the floor. It is not too much of a job to position a heavy load within 0.005 in. with this control. In fact, a raw egg can be placed on a spring scale and a 38-ton load lowered onto the egg, depressing the scale to about two lb and then raised without cracking the egg. In addition, the 38 tons can be lowered until the spring scale reads about eight lb which usually just cracks the egg but does not break it. Due to lack of quality control by the hens, these figures should be considered approximate only.

A substantial number of these cranes have been built and placed in service over the last 18 months or so. Several of these have been subjected to severe duty requirements and have given very satisfactory operating results. The crane shown in Figure 9, for example, has two hooks, each having a maximum speed of 200 fpm. It lifts automobile bodies from a trailer, a distance of about 35 ft, racks over a short distance, matches speeds with a conveyor, sets the bodies on the conveyor and returns to position once about every 45 sec, 24 hr a day, 6 days a week. If this crane fails to operate, the plant is virtually shut down, but the crane has not failed yet. Another crane in the area operates in the burning room of a large company and has been operating 24 hr a day, 7 days a week for about 18 months without difficulty.

Figure 10 shows a two-trolley hydraulic crane operating in a steel warehouse. Each hook has the two-speed shift arrangement which adds considerably to the speed and flexibility of the crane operation. Note particularly the absence of equipment on the bridge. The operators like the crane.

Most of the hydraulic cranes now in operation are considered Class 3 and Class 4 from a structural and duty standpoint. Capacities range from 1000 lb to 50 tons and larger cranes are under consideration. These cranes are operating both indoors and outdoors.

SUMMARY

1. Safety—Extremely good. If either power or hydraulic pressure fail, the valves close automatically blocking further load movement and the friction brake sets.

2. Control—Meets and exceeds the 200 to 1 speed ratio requirement. It will allow very slow speed with a maximum load without special controls or adjustments and still has a sharp, crisp control response. Because the control is stepless and highly responsive, higher operating speeds may be safely used which results in considerable increase in crane utilization.

3. Maintenance—The electrical system of the crane has been very much simplified and uses standard electrical components. During operation, no relays move and no contacts are made or broken. In fact, the only moving electrical part of the system is the rotor of the electric motor. As to brakes, the hydraulic valve which blocks the flow of oil to obtain braking action will not wear out or require adjustment for a very long period of time. The friction brake has little to do except to hold the load still and this does not produce brake wear. What little wear does occur is taken up by a long brake spring so that only very infrequent adjustment should be required. The hydraulic pumps and motors will gradually wear out over a period of years, resulting in a loss of speed, but can be easily and inexpensively replaced by ordinary maintenance labor at a convenient time. ▲

Inland's New Automatic Slabber

Complete automation of Inland Steel Co.'s slabbing mill has increased productivity and quality and developed electrical knowledge which will have further applications in the future.

PART I—THE MILL

by E. R. MC GAUGHEY
Superintendent
No. 3 Bloomer and No. 4 Slabber
Indiana Harbor Works
Inland Steel Co.
East Chicago, Ind.

INLAND Steel Co.'s automatic slabber, erected as part of the 1955–58 expansion program, was conceived after many months of deliberation regarding the plausibility of continuous casting. A highly productive mill with a capacity potential for all foreseeable future primary expansion was required. A universal slabbing mill in conjunction with automatic punched card rolling was the final decision. Ingot delivery, slab handling and crop and scale removal were designed to handle the full capacity of the mill, and 18 pits were constructed to fill immediate needs with an eye toward future expansion to handle the ultimate mill capacity by the addition of more pits.

Prior to actually planning it was noted through visits to other plants that on manually operated slabbing mills, the edgers or vertical mill were being used for drafting in one direction only, that is, on passes from the edger to the horizontal mill.

The desire to eliminate these idle passes on the vertical mill was basically the reasoning behind the decision to install the mill with the latest type of automatic programmed control system. This control would provide the accurate speed matching between the two mills which is necessary with the vertical mill drafting in both directions.

Because programming of the mill permitted preset rolling patterns, maximum efficiency of the drives at all times was possible. This included maximum drafts with maximum speeds at the same time eliminating some of the human failures, which are too frequently the cause of breakdowns on a mill of this type. To enumerate several additional advantages considered:

1. Consistency of slab sections off the mill.
2. Complete control of rolling practices.
3. A substantial reduction of physical fatigue to the roller.

Because complete automation had not been developed at the time of the original decision, the mill was equipped with semi-automatic controls, i.e., partially automatic and partially manual operation.

The original concept incorporated within its scope two different modes of operation.

1. Full manual for both rolling and manipulating. Included were manual controls of all drives at the roller's station. In addition, the manipulator operator controls were mounted on portable tables.

2. Semi-automatic control in which the following basic functions were programmed:

(a) Main mill screwdown positions.
(b) Edger mill screw positions.
(c) Main drive speeds.
(d) Edger drive speeds.
(e) Draft compensation for rolling in either direction.

For ease of operation, the mill and mill tables were both incorporated in the same manually operated master controller.

Although the original concepts have been altered to some degree, basically the following semi-automatic routine was established. With semi-automatic selected, the mill operates as follows. With a punched card in the card reader and the selector on "Semi-Auto," by pressing the reset pushbutton, first pass information is read and screws move to the punched positions.

The pass indicator indicates pass number which in this case would be No. 1. The roller then moves the table master controller which starts the mill and table rolls. As the ingot leaves the mill, the roller pushes the

next pass push button and reverses the master switch to begin the second pass, etc.

After the first, second or third pass, depending upon the section to be rolled, an indicator light is activated by the card reader notifying the roller that manual manipulation is required. While manipulation is being performed, the two mills are automatically positioned for the next pass. On completion, the roller merely moves the master controller in the desired direction and continues rolling.

The last programmed pass is indicated by a pilot light. On completion of this pass, pressing of the "next pass" pushbutton causes the first pass information to be reread and first pass functions actuated. It is not necessary to push the reset button again until a new card has been inserted.

Six months or so after the original decision, the control designers had made such tremendous advances in complete automation that Inland decided to "shoot the works," so to speak, by extending the control system to incorporate complete automation or programming.

In the opinion of the company there were several advantages to complete automation which merited the additional cost:

1. Almost complete elimination of the human error was contemplated.
2. More consistent mill output brought about by a decrease in the number of manual operations required.
3. Further reduction in the amount of physical human effort required.

Full automation, in addition to the semi-automatic features, incorporates the following activities:

1. Direction of both mills.
2. Table directions.
3. Table speeds.
4. Sideguards positioning.
5. Ninety degree manipulation.
6. One hundred and eighty degree manipulation.
7. Tandem rolling.

Figure 1 shows the horizontal and vertical mills, manipulator sideguards and tilting fingers on both sides of mill, and the location of each of the seven hot metal detector stations.

Basically the mill operates as follows when full automation is selected: Pressing the "reset" button initiates reading of pass one. Edger and horizontal rolls are moved to punched position and sideguards are moved to extreme out position preparing the mill to receive the first ingot.

The ingot approaches mill on the run-in tables under manual control. Initiating the pass advance pushbutton starts the mill and table forward at entry speed to receive the ingot.

Hot metal detector No. 1 sees the ingot first and moves the sideguards from the extreme out position into the punched position. Sideguards are electrically tied to the edgers and aline themselves automatically to the edger settings, plus one half in. on each side, allowing for variations such as spread, split ends, scrap, etc. However, in the cases of last passes, manipulations and ingot initial entry onto mill tables, either the punched card or the hot metal detectors initiate variances from this routine.

Hot metal detector No. 2 is used to stop the table rolls if sideguards have not reached their punched position. It also used for positioning the ingot over the manipulator fingers when manipulation is required after an even numbered pass.

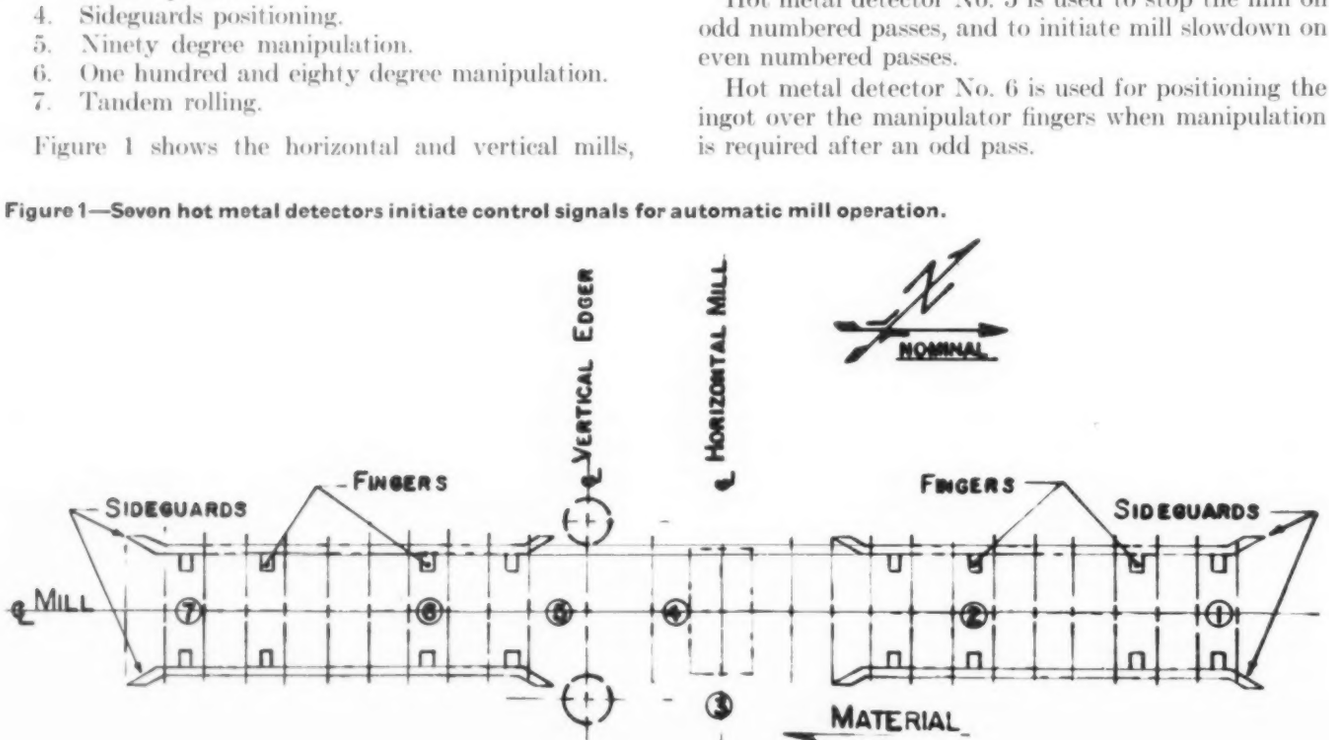
Hot metal detector No. 3 is used to initiate mill acceleration in both directions and to stop the mill on even numbered passes. It is also used to initiate mill slowdown and screwdown on odd passes.

Originally detector No. 3 was placed on the entry side of horizontal mill but was moved to center line of mill for more efficient operation. This change also permitted the elimination of station No. 4 which is temporarily disconnected but may be used in future developments.

Hot metal detector No. 5 is used to stop the mill on odd numbered passes, and to initiate mill slowdown on even numbered passes.

Hot metal detector No. 6 is used for positioning the ingot over the manipulator fingers when manipulation is required after an odd pass.

Figure 1—Seven hot metal detectors initiate control signals for automatic mill operation.



Hot metal detector No. 7 is used to position sideguards in extreme out position preparatory to receiving the next ingot.

With the same card in the reader, activating the pass advance button sets horizontal mill at desired opening and vertical mill at 40 in.

For those familiar, it probably goes without saying there were several disadvantages of serious consequence that had to be considered after full programming was accepted. Irregularity of ingot temperatures from the pits would certainly have an undesirable effect on the over-all performance of full automation.

With a limited pit capacity, a situation which can have a damaging effect on quality and performance, requiring constant policing by supervision, the prospects seemed quite clear that two different groups of cards were a necessity, one with drafting practice commensurate with good soaking pit practice and the other with lighter drafting, allowing for somewhat colder or unevenly heated ingots. The two cards were to be inserted into the dual card reader, one on each head, and thus with a flick of the switch the roller could operate off either of the cards.

However, the task of developing the initial group of cards was such a large one it was decided to start the mill with but one set and depend entirely upon a good job of heating.

Manual operation of the mill, when handling improperly heated ingots, was such a laborious job and extremely slow so that the roller soon developed the practice of returning those ingots to the pits without the slightest hesitancy. This practice developed into a very effective control of pit personnel.

In addition, with the new mill in operation, Inland now had more than adequate primary capacity permitting almost unlimited control on those operations affecting quality, pit and rolling practices. It was because of these circumstances that the original plan was changed from the two card setup to a single set of cards which included drafting practices allowing but slight variations from the ideal and compensated to a very small degree for something less than perfect heating from the pits.

This chain of events and reactions have, without a doubt, had a favorable effect on the quality of slabs presently being produced by the mill.

Another disadvantage to be overcome was damage caused by cobbles in the mill with but one man at the controls to maneuver the mill. This problem has not been completely resolved, but it has been minimized greatly by the installation of a "crash" button which on being depressed stops all activity instantaneously. In addition, the hand master controller has been so wired to take preference over all other controls on both the mill drives and tables.

With the large amount of ingot scrap generally associated with rimmed steel, which comprises 75 per cent of the total mill products, scrap on the back mill tables, which could not be seen by the roller, presented another problem. This problem was solved to a great degree by the installation of a closed television circuit with the camera trained on the back side of the mill. This permits the roller to visually inspect the back tables when necessary.

Further difficulty was created by the fact the operator's pulpit was situated on the down stream side of the mill making it impossible for the roller to inspect the ingot size before rolling. Here, another closed circuit television is used, with the camera positioned at 90 degrees to the ingot scale table approximately eight ft above the floor. In this position the camera looks directly at ingot as it is being weighed. The receiver is located in roller's pulpit with the screen calibrated to indicate the width of the ingot as it lays on table.

The introduction of automatic controls created another problem necessitating a study of screw speeds. To minimize as many mill limitations as possible the original edger adjust speed was changed from 7.4 to 12.5 fpm. This reduced some of the minute delays after manipulation while the vertical mill was still positioning for the next pass. Several minor changes can be made in the future to increase the edger adjust speed to 16 or 20 fpm if the need arises.

The development of the initial rolling patterns prior to startup was a tremendous project. Considerable amounts of research and investigation of the many facets of hot rolling had to be accomplished. The theory of hot rolling was reviewed by seeking information from various books and magazine articles and by consultation with many individuals familiar with this subject both within and outside the company.

Early in the development stages of the rolling patterns it was recognized that speed matching of the horizontal and vertical mills was of vital importance. With this problem in mind several investigations and experiments were made under actual operating conditions on the blooming mill. For example, high speed photography in conjunction with a chronometer were used in an attempt to accurately measure forward slip. This approach proved to us that forward slip did exist in blooming mill rolling, although this method did not result in sufficiently accurate data. An electro-mechanical device was then created which measured exit speed of the bar and roll speeds simultaneously, and provided the necessary data needed. The results of the tests indicated that under varying conditions 3½ to 7 per cent forward slip could be expected. To compensate for this amount of elongation, and after considering the droop in the electrical equipment, proper allowances to the draft compensation were made. Examination of mill speeds and mill current recordings reveal an outstanding job of speed matching has been accomplished.

Data was accumulated regarding the spread of slabs at various thicknesses for various percentages of draft. Information was also compiled regarding the amount of shrinkage that could be expected on various slab widths and thicknesses. Although the blooming mill rollers make adjustments for shrinkage, the use of punched cards necessitated accurate and specific allowances for it. In addition to these allowances, under actual operating conditions, the roller must trim his mill on the last pass to increase or decrease thickness enough to make the proper slab weights.

Recordings were also made of the manually operated bloomer to determine the speed settings of the mill at various stages of the rolling practice.

During the analysis of all of the tests, careful attention was given that each of the tests had been carried out under various operating conditions and that a

normal distribution of product mix was included in the samples.

After many months of research and consultations, the ground work for the first series of cards was completed. Certain basic criteria were established and are as follows:

1. All ingots will enter mill on edge on first pass.
2. All patterns completed in odd number of passes.
3. All ingots possible to enter mill top first on first flat pass.
4. Initial edge pass by horizontal mill designed to remove taper and square ingot. Vertical rolls to be set at 40 in. to eliminate possibility of ingot falling into openings between edger rolls and skid plate.
5. Horizontal drafts of all ingots not to exceed 2½ in. or 22 per cent during breakdown on the flat.
6. Edger rolls to maintain slab width on odd passes.
7. One and one-half in. maximum edge draft on even passes for all ingots.
8. No edge reduction by vertical mill while ingot is over 25 in. thick.
9. Speed settings or draft compensation based on original ingot or slab thickness.
10. Forty per cent of the given draft was used for the spread factor in determining draft compensation for speed matching.
11. Draft of finished passes should be as light as possible and not to exceed one in. to eliminate overfilled edges.

The format for a rolling pattern which would encompass all slab widths and thicknesses out of each ingot was completed. From this format the machine accounting department developed a program to be used on a computer from which the many rolling patterns were developed, printed, checked and finally punched on cards. Each card contains the complete rolling pattern for each slab section out of each ingot.

A typical punched card is divided into two sections providing a maximum number of 23 passes. A second card can be used if 23 are insufficient.

The reading head reads the first half of card from top to bottom then down the second half.

Each card contains the following printed information:

1. Schedule number which indicates ingot size, finish slab width and thickness.
2. Date.
3. Number of passes to complete section.
4. Ingot thickness.
5. Ingot width.
6. Finished slab width.
7. Finished slab thickness.
8. Pass number.

The punched holes include the following information and controlled activities:

9. *Last pass*—Resets mill for first pass of next ingot.
10. Schedule numbers used by the computer.
11. *Screwdown opening*—The horizontal mill settings are in ¼-in. increments. All slabs for hot mills and plate mill are ordered by ¼-in. increments of thickness.
12. *Mill speed*—Six different speed settings ranging from 0 to 80 rpm in approximately 13 per cent increments.
13. *Edger opening*—The vertical mill settings are ½-in. increments. Likewise all slabs ordered by ½-in. increments of width.
14. *Mill draft*—The horizontal mill draft compensation for speed matching even passes is in five per cent increments ranging from 5 to 50 per cent.
15. *Edger draft*—The vertical mill draft compensation for speed matching odd passes is in 1½ per cent increments ranging from 1½ to 15 per cent.
16. *Turn required*—Provides 90 and 180-degree turns.
17. *Finger height*—There are seven different finger positions at 7-in. increments. This is done in the interest of minimizing time delays in manipulation.
18. *Tandem rolling*—All cards are punched for tandem rolling, when rolling singles roller selects nontandem.
19. Card alinement.

Figure 2—Ease of operation and operator convenience was stressed in the layout of the operator's pulpit.

Ten cards were made for each rolling section and there are approximately 1000 rolling sections for each of the ten ingot sizes. It was expected at the outset that the original inventory of cards would be used only during the shakedown period and that several revisions would be made before the optimum practice would be developed.

The mill rolled its first ingot on October 27, 1958, by punched card under semi-automatic mode of operation. By the third ingot it was evident that the inventory of 100,000 cards was destined for the pits. Over-filled edges were very apparent on the surface of the slab and readjustment of the edger settings on the finishing passes had to be made to provide the desirable slab flatness with acceptable edges. After several weeks experience, having punched cards manually on a day-to-day basis, a second series of cards was then developed.

A third series of cards with lighter draft practices and slower mill operating speeds was put into operation after encountering a period of roll breakage problems.

The decision to roll all ingots "butt first" necessitated the development for a fourth series of cards which includes heavier drafts and faster roll speeds than the third series.

The current rolling patterns, although not an optimum practice for certain conditions, provides the best results under present operating environment.

Considerable time was spent in laying out the rollers station to make it as convenient and flexible as possible. Figure 2 shows the position of the various controls and auxiliary equipment located in the operators pulpit.

In the pulpit are: (1) indicator lights in two small boxes immediately above right-hand screw indicator dial, indicating (a) ingot size, coded; (b) finished slab size; (c) pass number; (d) last pass; and (2) television.

In spite of the many difficulties experienced during the shakedown period, programming has been quite successful. The degree of success attained can be measured by the very small number of ingots actually rolled by manual operation.

The mill began operating with a roller and a temporary manipulator man. This was felt necessary to ease somewhat the pressure on the roller during his training period, and at the same time give the second man some experience on the roller occupation. However, an extra man was kept in the pulpit on each turn as a roller learner for a period of two months. After five months of operation, four men were qualified to roll the mill. This was found to be another distinct advantage of full automation in that it is possible to train a roller in considerable less time than it takes on a manually operated mill. In addition it has been recognized that a man does not necessarily need previous manipulating experience.

As a matter of interest, the mill has established the following records: a best turn of 2718 tons, a best hr of 563 tons, best hr of 32 ingots, an average tons per turn best month of 1991 tons and an average tons per hr less delays of 367 tons.

The mill is built entirely on new land created by the filling of lake property. This necessitated the use of pilings. Piles were all driven to refusal which averages approximately 100 ft below datum.

Excellent co-operation from the many different suppliers and Inland Steel Co.'s own field force group permitted the first slab production in a record 21 months after the first purchase orders had been issued.

PITS

The pit building situated in line with the mill building is 694 ft-9 in. long, 104 ft-0 in. wide at crane rail height and 43 ft-0 in. from ground to crane rail.

The pits, shown in Figure 3 are of the rectangle top one-way fire type, measuring 22 ft-0 in. in length, 8 ft-6 in. in width and 13 ft-6 in. deep and are placed in the center of the building with two ingot delivery tracks on one side of island and the two ingot buggy tracks on the other.

Pits are arranged in six batteries with three holes per battery for a total of 18 and have an average capacity of 100 ingot tons per charge. Hearth coverage averages 38 per cent under normal operating conditions.

Because waste heat boilers are attached no recuperators are used, consequently pits operate on cold air and produce at the rate of approximately 1,250,000 Btu's per slab ton produced. Combination burners are furnished allowing the use of either fuel oil or coke oven gas.

Controls of pits are of the latest design and consist of temperature control, fuel-air ratio, accelerated heating devices, and hydraulically operated pressure regulation. Pressure in each hole is controlled by an individual plastic damper with water cooled frames.

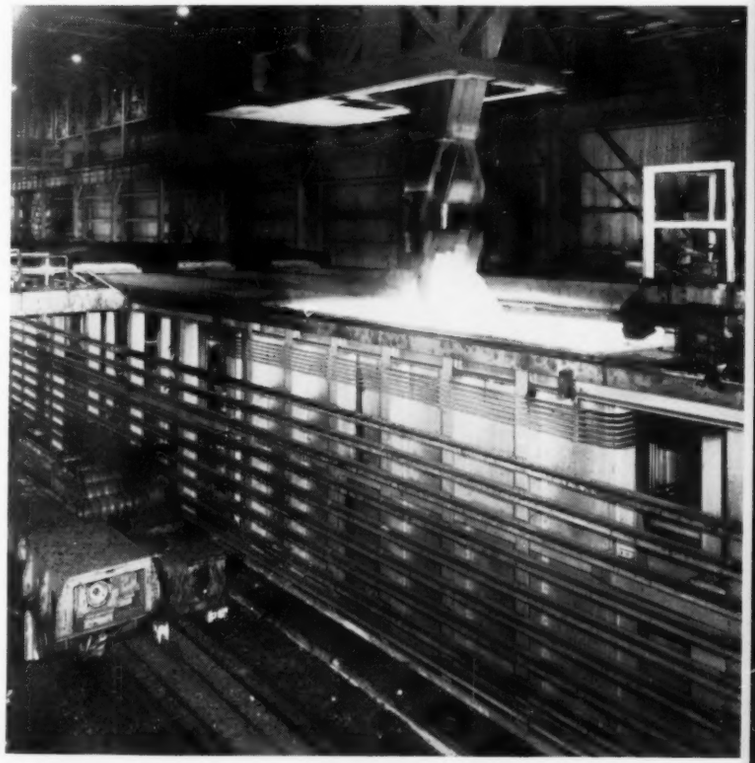
Platinum-rhodium thermocouples are placed one in each end wall 48 in. below top of curb tile. Thermocouples are wired such that either one may be used. Pits are generally operated off both couples simultaneously which permits the recording of the mean temperature within the pit.

Combustion air is supplied by 6500-cfm common shaft fans, and 18-in. silica fire stone is used as lining, backed with a light-weight castable refractory. The stone is supported by a 30-in. highwall of chrome brick and topped with two courses of super-duty fire brick upon which is laid a course of shape brick comprising the trough or sand seal. Covers are of the double sprung arch type and all are plastic ram material.

Coke breeze is used as a bottom cover and bottoms are remade on an average of every 36 to 40 hr. Two coke breeze pits (one at each end of building) provide adequate breeze storage. Breeze is loaded into crane operated coke boxes by a small electrically driven pay loader. All breeze is delivered by a dump truck eliminating the need for railroad switching service.

Pit cinder is dropped through the two cleanout holes into cinder boxes placed directly under holes. After loading, boxes are then conveyed by fork tractor to skip hoist which lifts the cinder from the basement and deposits it into standard railroad dump cars outside pit building.

Figure 3—Each of the 18 pits has a capacity of 100 ingot tons.



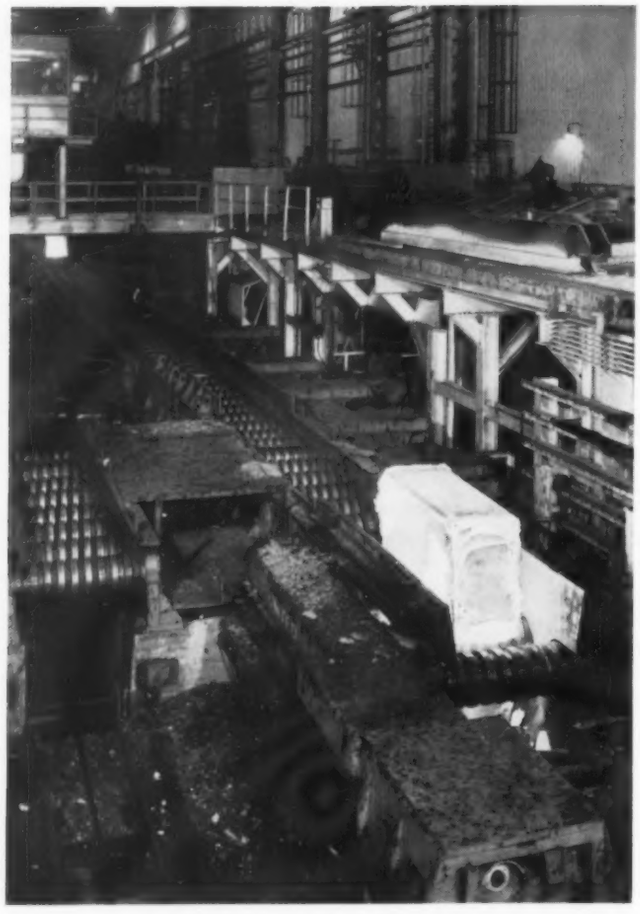


Figure 4—Each ingot receiving table is capable of handling two ingots for tandem rolling.

Pits are serviced by two over-head 35/35 ton, stiff legged pit cranes and two 60-ton capacity cover cranes with a span of 38 ft-6 in. Cover cranes are capable of hoisting any two covers in a given battery simultaneously. Travel speed is 100 fpm.

For maintenance purposes a 25-ton capacity repair trolley, which travels the full length of the building, is mounted in the superstructure of the pit building.

Waste heat boilers are attached, one to each battery. Boilers are of the standard water wall type capable of producing 30,000 lb of steam per hr at 275 psi. Each boiler is equipped with two steam atomized oil burners to supplement the waste gases and automatically cut in when steam pressure has fallen below the desired preset amount. A hot line zeolite external water treatment plant is furnished to minimize boiler maintenance and increase steam producing efficiency.

Two 75-ton traveling table type, rope propelled ingot buggies are provided. Each buggy is equipped with five 14-in. diam x 48-in. body grooved rolls set on 18-in. centers. Scale and capping plates are collected in a bin mounted under the rolls which dumps automatically into a drag conveyor at receiving table bumpers.

Twin ingot receiving tables shown in Figure 4 are 20 ft-0 in. long. They are located at the mill end of the buggy tracks and are composed of nine 18-in. diam x 48-in. body table rolls set on 30-in. centers. Each table is divided into two sections, each section driven by its own individual reduction and motor. This arrangement provides for the handling of two ingots on each table when rolling tandem.

Receiving tables deliver ingots onto sideshifter table which travels in a transverse direction and is capable of handling two ingots end to end. This traveling table is also 20 ft in length and consists of two individually driven sections one of four and one of five rolls. Table rolls are 14-in. diam x 48-in. body set at 30-in. spacings. Traverse speed of sideshifter is 100 fpm and is driven by a 50-hp, 550-rpm, 230-volt, compound motor mounted on the frame of the shifter.

From the sideshifter ingots are conveyed onto the No. 1 mill run-in table. This table is 26 ft-7 in. from center of end roll to center of opposite end roll and is composed of 12 rolls, 18-in. diam x 85-in. body on 29-in. centers. The entire table is set within the confines of the pit building enabling the pit crane closest to the mill to deposit ingots directly onto the table in the event of breakdowns on any of the preceding equipment. In addition the second pit crane is capable of placing ingots onto the receiving tables if both ingot buggies are out of operation.

The No. 2 mill run-in table or scale table is a duplicate of the No. 1 table; however, a 75-ton ingot weighing scale is located under this table.

Attached to scale, which is activated from the ingot buggy operator's pulpit, is an automatic electronically controlled totalizer located in the mill office. As an operator is notified of heat changes, he manually punches the heat number on the panel board of push buttons provided. Heat number is recorded on tape and all subsequent ingot weights appear under this number. Prior to inserting a new heat number, the totalizer button is punched by the buggy operator thus totalizing the accumulated weights of the heat processed.

Following the scale table is the mill approach table, which is a duplicate of the two previous mill run-in tables.

Incorporated in this table is a disappearing roll operated by an air cylinder and controlled from the roller station. With the dropping of the roll a void in table line is effected permitting the entrance of large pieces of scrap. Under the opening, a sloping chute receives the scrap and directs it into a large heavy duty scrap box set under mill floor level 18 ft-6 in. from the center line of the mill table. A similar chute and box arrangement is provided on the exit side of mill where the second table roll is simply removed from the No. 1 mill run-out table creating a permanent opening.

MILL

Figure 5 shows the mill proper, scarfer and shear housed in a building 432 ft-0 in. long, 100 ft-0 in. wide between crane rail centers and 50 ft-3 in. from floor to crane rails. Building is serviced by one 120/30-ton overhead crane.

Strategically placed inside the mill building are four transfer cars; one with rails extending into pit building, one extending into crop disposal building, one transfers material into slab yard and the fourth connects the mill and motor room.

The only other items within the mill building are one large and one small grease pumping stations, the auxiliary crop disposal system, a degreasing pit, roll storage racks, large "C" hook for changing vertical rolls, two large covers protecting the floor opening

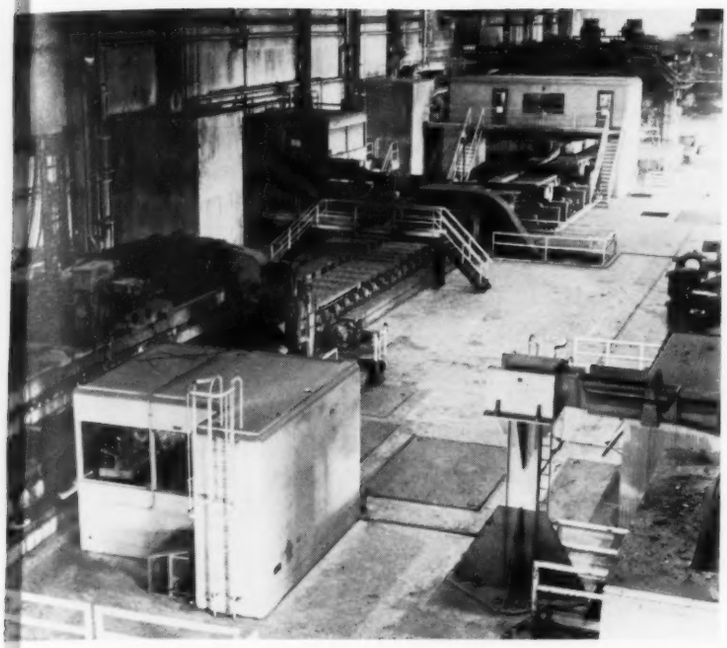


Figure 5—The mill, scarfer and shear are operated from individual air-conditioned pulpits.

through which the hydraulic accumulators operate and three operator's pulpits.

The mill consists of a typical high lift reversing slabber and a vertical mill set on 8 ft-1 in. centers.

The horizontal mill accommodates 46 x 90-in. work rolls with a maximum opening of 83½ in. Mill windows are 48½ in. between steel liners which are 19 ft-4½ in. high. Post area of horizontal mill is 750 sq in. Horizontal rolls are set in roller type bearings mounted in steel chucks. Sled arrangement is used for changing rolls, which has been accomplished in one hr and forty minutes. It is anticipated that this operation will eventually be performed in thirty to forty minutes as more experience is accumulated.

Top roll balance is accomplished through quadrants and chains to which counterweights are attached exerting a constant pressure against top roll regardless of position.

Screws are 18 in. in diameter with a 2½ in. pitch and have rated speed of 597.4 in. per minute at 1100 rpm of motors. Screws are driven through 4.4 to 1 reduction from motors.

The two 37 ft-6 in. spindles are duplicates and are carried in babbitted mountings supported on carried bars. Spindle bodies are 23 in. in diameter. Top spindle attains an angle of 6 degrees-23 minutes above horizontal at maximum opening and a 5 degrees-20 minutes angle below horizontal at minimum opening. The top spindle is mechanically balanced with hydraulic adjustment for changing rolls.

The two housing rolls, 21-in. diam x 90-in. bodies, are mounted in ports through housings on bronze bearings. The feed roll on the entry side is mounted in bronze bearings clamped in saddles outside the mill housing. Each roll is individually driven direct from motor.

The vertical rolls, 36 in. in diam x 84 in. body are mounted in roller bearings and are locked within movable housings, 26 ft-7 in. high. Entire weight of housings, rolls, bearings, chucks and other miscellaneous appurtenances is supported at the top on bronze liners attached to rest bars bridging the two vertical stationary legs.

Drive reductions of the edgers are set at an elevation which eliminates the need of vertical spindles, and 750-psi hydraulic pressure applied through 4 cylinders, 2 each side exerts the necessary pullback pressure to keep the edger housing against the adjust screws at all times. Maximum opening is 90 and minimum is 20 in.

Front and rear mill tables are duplicates, and are 31 ft-5 in. from end roll to center of opposite end roll. Each table consists of 14 rolls 20 in. in diam x 101 in. body. Individual motors drive each roll directly through spindles. Rolls are mounted in roller type bearings on both ends.

Manipulators are furnished on both sides of mill. Guards are 25 ft-9 in. long with 20 ft-11 in. of flat working face and are so arranged mechanically that a failure of either one of the drive reductions or motors the manipulators can continue to operate off the opposite drive by opening couplings.

Four tilting fingers are installed in each of the left hand guards. Drive mechanism is so designed, using a series of cams, linkages and wheels, that jamming it is impossible if the fingers are lowered atop slab or scrap.

The entire mill and manipulator areas are undermined with a system of trenches and drains to facilitate cleaning. At strategic locations, openings were placed in floor leading to trenches below. This permits the washing down of all equipment and floors in the areas which are prone to accumulate considerable dirt and scale off the mill.

SCRAP HANDLING

The difficult problem of ingot scrap and scale has been solved by a combination of four distinct methods of handling.

Scale, capping plates and ingot scrap accumulated from the ingot buggies, receiving tables, side-shifter and the three run-in tables, falls through tables and is deposited into a dry flat bottomed trench. Located in

Figure 6—Scrap and scale from the entry side of the mill fall into a dry trench which is kept clean by a cable driven scoop.

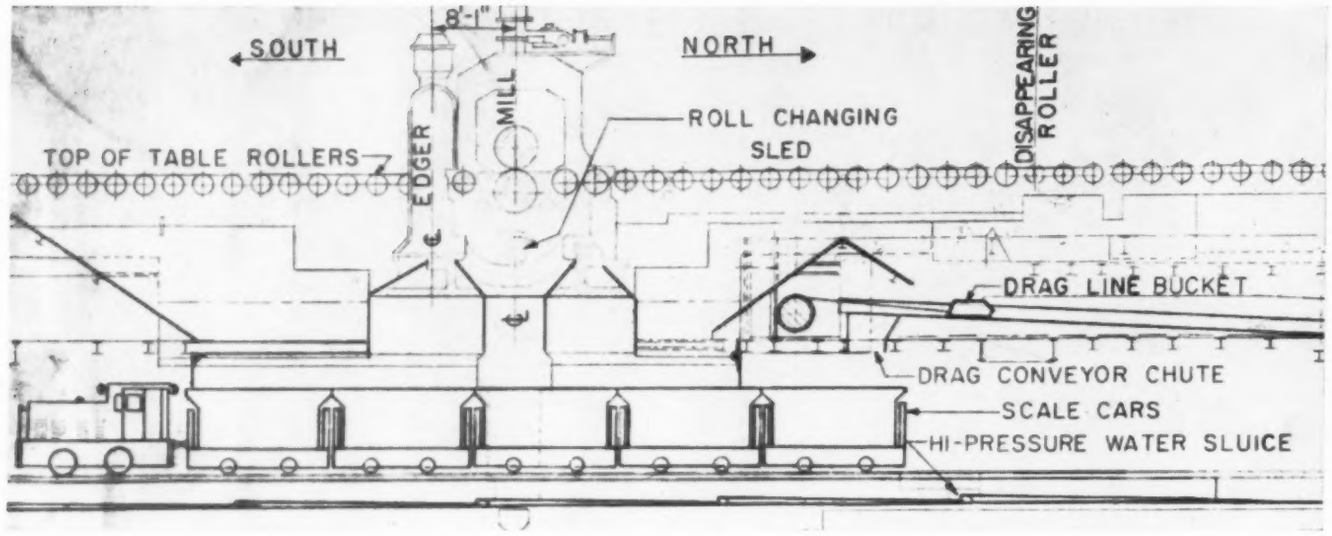


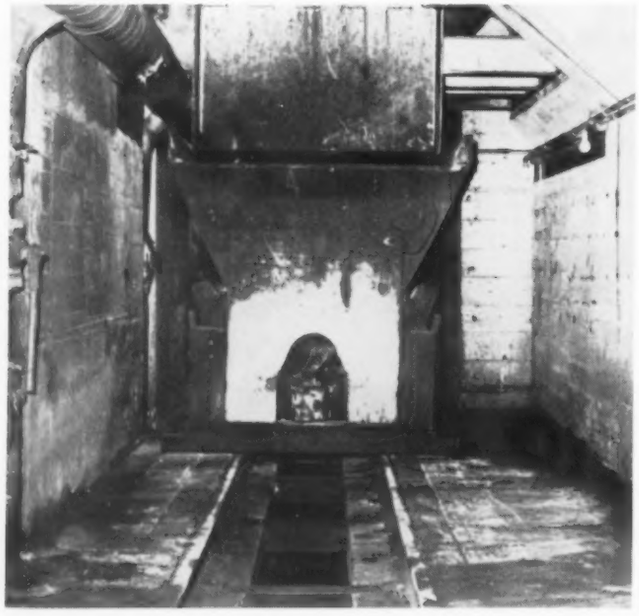
Figure 7—All scale and scrap is finally dumped into one of a series of scale cars under the mill.

the trench is a cable-driven scoop with an electrically driven drum on each end. As can be seen in Figure 6, the scoop is designed to ride up and over top of scale or scrap deposits as it is pulled in the reverse direction. Starting at the point where scale is dropped from the ingot buggies, the scoop pulls the scrap up the inclined trench dropping it through an opening at the opposite end 180 ft distant. At this point scrap falls directly into a small car on a lower level.

Scrap and scale accumulated from the mill proper and mill tables are handled in a somewhat unique fashion. Starting at a point 27 ft-2½ in. from the center line of mill on entry side and extending under mill to a 40 ft-6½ in. from mill center line on the delivery side, all scrap is dropped directly into cars positioned on a track 25 ft-2½ in. below pass line. Figure 7 shows a side elevation and general arrangement under mill.

The sloping and vertical side plates, all of high wear resistant steel, extend from the base of the table beams to a point four in. below and inside top edges of cars. See Figure 8. Cars are so designed that no opening exists between them as they are pushed under chutes. This arrangement makes it all but impossible for either scrap or scale to lodge outside confines of car bodies.

Figure 8—The chute plates extend below the sides of the cars to prevent scale from dropping outside of the car proper.



Derailments under the mill were a problem of some concern during the engineering phases of the system but as of this writing only one has occurred and this was caused by a piece of scrap which dropped from above during a repair turn when all cars were out from under chutes. In replacing the cars, the first one through jammed against the scrap causing the front wheels to leave the rails.

A high pressure sluicing system was installed between the rails to handle water spillage and any light scale washed over top of car sides. Two small mine type diesel locomotives provide the power for moving the cars. One is in service at all times and the other a spare. An underground garage incorporated in the system permits minor repairs to locomotives or cars without having to remove them from system.

Cars are of extra heavy duty design including both body and undercarriage. Due to recessed couplings, it is impossible to couple cars to each other; however, the engines have extended couplers for this purpose. Side dumping in either direction is possible allowing for the turning end for end of cars to equalize wear on wheels and under trucks. Each car has a capacity of 12 tons or 160 cu ft.

At the dumping station, Figure 9, an overhead electric hoist is mounted which dumps the scrap into a water filled pit adjacent to the tracks. From the pit an overhead cable crane lifts it to a sifting screen on top of standard gage railroad gondolas for shipment to other parts of plant.

Depending on mill production, cars are moved every 20 to 40 min. As the north car has been loaded with scale from dry scale drag, the engine pushes an empty under the chute at the south end. The engine then returns around the loop to the north end, couples onto the loaded car and sets it at the dumping station beside the north scale pit. After unloading, the engine pushes the car to the south end and parks it on end of drag until time for next push.

As cars are moved along under the mill into the different positions they receive varying amounts of scrap and scale. At no time are they left under chutes long enough to become fully loaded. Most cars reach the last position under the dry scale opening about one half loaded. It is at this point that the loading is completed.

Commencing with last roll on table line at the slab pilers, a high pressure sluicing system picks up all scale under tables and delivers it into the south scale pit.

Scarfer slag and scrap are handled in a separate system consisting of a large basket at the bottom of a chute and an individual sluice which picks up slag under the basket and delivers it also into the south scale pit.

With the exception of the area under mill where scrap cars are set, all sluices, trenches, baskets, etc., are designed to give ample clearance for men to work while mill is in operation.

SCARFER

The four-sided hot scarfer is located 137 ft-2 in. from the horizontal mill. The scarfing machine is comprised of 20 working heads, eight heads make up the upper unit, and eight the lower unit with two heads on each side. Each head carries the slotted nozzle design. Scarfing limitations range from 3½ to 12 in. in thickness and 17½ to 76½ in. in width. Scarfing speeds of 65 to 195 fpm can be attained and the minimum slab length scarfed is 16 ft. Slab surface removal varies from 1/32 to 1/8 in. and is controlled by two methods. First, oxygen cutting pressure of 32 psi is used for light or normal removal, and 40 to 45 psi is used for heavy removal. Second, table speeds of 100 to 110 fpm are used for light removal, and 70 to 80 fpm is used for heavy removal. If desired, a combination of the two methods can be used. On this particular application it was found more desirable to change the cutting oxygen pressure to obtain the desired cut rather than change the table speeds.

Figure 9—Cars are designed to permit dumping from either side.

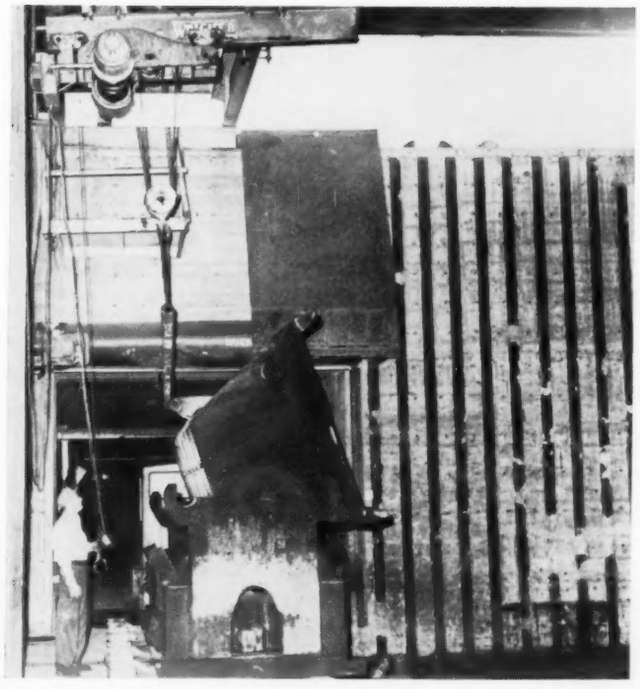


Figure 10—An auxiliary crop disposal system permits segregation of special scrap when required.

SHEAR

The hot down-up cut shear is located 74 ft-4½ in. from the scarfer and 211 ft-6½ in. from the horizontal mill. The shear is motor driven with each knife being hydraulically balanced with a weight type hydraulic accumulator producing 1000 psi. The hydraulic system also operates the hold down gag on the delivery side of the top shear knife head. The shear has a maximum knife pressure of 3,750,000 lb with a capacity to shear carbon steel slabs up to 900 sq in. or a 75 x 12-in. slab. The shear knives are 4 x 9 x 85 in. and for the ease of handling are divided into two sections. The stroke is 19 in. with a 1½-in. overlap. The bottom knife is set one in. below the table line giving a clear opening of 16½ in. The bottom knife through rocker shaft links and levers is balanced by hydraulic cylinders mounted to the side housings.

In actual operation the top knife with the hold down gag, which is preset by shearman, is stopped slightly short of the slab—the bottom knife then rises, shearing the slab on the up stroke. The upstroke method of shearing is designed to minimize slab shear distortion. Shear speed is 18 cuts per min.

A motor operated shear gage measures lengths as desired in a range 4 to 30 ft. Carriage traverse is accomplished through two forged steel screws, 12-in. diam x 1½-in. pitch, operating in bronze nuts in a drag block.

CROP DISPOSAL

A pull back table permits crops to fall on to a heavy fabricated chute located on the delivery side of the shear. After a 90-degree turn into the second chute they are deposited into the crop hoist car.

As each car is loaded the operator pushes a button which closes the gate at the bottom of the chute ar-

rangement and the car starts its run up the incline. After dumping, it returns to the bottom position and the gate opens. All movements are electrically interlocked for the convenience of the operators.

Crops are dumped into a deep water-filled pit located in the crop building. After cooling they are loaded by magnet and crane into gondola cars especially designed for this service.

Located on the entry side of the shear is a test piece conveyor. In operation, a 12-in. air cylinder drops the shear apron and the test piece drops into the opening. Here it is chuted onto a roller chain conveyor and brought up to floor level for identification then deposited into a storage box.

Another television camera is located on the entry side of the shear with the calibrated receiving screen in the shear pulpit giving the operator a full view of the slab. This enables him to control shearing tolerances very closely.

AUXILIARY CROP DISPOSAL

Located 65 ft-10 in. downstream from the shear is the auxiliary crop disposal system. This arrangement, shown in Figure 10, serves the dual purpose of special scrap segregation and regular butt removal during delays on the main system.

Crops are pushed off the table line by a small slab pusher and chuted into one of two large fabricated steel boxes set below floor level and just off the table line. Incorporated in the chute is a motor driven deflector plate which directs the crops into either of the boxes. As one box is loaded the mill crane dumps it into a second chute located in the mill wall which directs crops into a water-filled auxiliary pit in the crop building. While this operation is taking place the second box is being filled.

The 60-ton capacity slab scale is located 113 ft-10 in. downstream from the shear and is capable of weighing slabs up to 30 ft in length. Attached to the scale is an electronically controlled indicator located in the shear pulpit.

STAMPING

The overhead slab stampers are located 161 ft-10 in. from the shear or 48 ft-0 in. from slab scale. This unit consists of four pneumatic cylinder type stampers mounted in pairs on two carriages supported by retractable steel arms from two overhead trolleys.

The trolleys being mechanically tied permit traverse movement of both units simultaneously across table line. As one unit is positioned on center line of table for stamping, the second unit is outside the table line ready for reloading.

Duplicate control stations are provided on each side of roller line permitting the two operators to alternately set heads with new heat numbers, slab letters or ingot numbers when necessary.

SLAB PILING

The slab piling area is located 190 ft-10 in. from the shear and extends into slab yard for a distance of 177 ft, making it possible for any of the first four slab yard cranes to service the mill. The slab and pile pusher

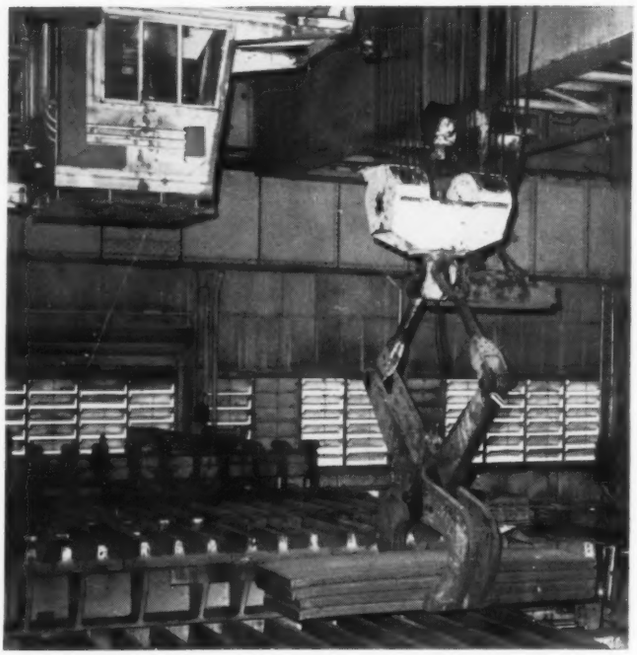


Figure 11—Slab handling tongs are used by all cranes in the slab yard.

operation is comprised of three duplicate units. Each unit consists of two pushers, one mounted above the other. The top pusher being used to push slabs onto the slab piler while the lower pusher is used to push piles of slabs from the piler to the storage racks. Slab pusher heads are made of cast steel equipped with thirteen forged steel top hinged pusher fingers on alternating 23 and 25-in. centers. The slab pusher speed is 90 fpm. Working stroke is 14 ft-7 in. with approximately 2 ft-6 in. auxiliary back travel to permit servicing of table line shafts. The stroke of the bottom piler pusher ram is 18 ft-1 in. Traverse speed of piler pusher rams is 58 fpm.

The elevator platform is made of heavy ribbed cast steel, 6 ft-5 in. wide x 32 in. long, mounted on two 12-in. diam by 3-in. pitch screws spaced on 17 ft-0 in. centers. The screws operate through standard, totally enclosed right angle reduction drive and bevel gearing.

Each slab piler table has one disappearing stop used to aid in positioning a slab. Through use of disappearing stops, two piles of slabs under 15 ft can be piled on each piler. The slab pilers will accommodate a pile of slabs 75 in. in width x 30 ft long and 39 in. high.

Piling facilities have a maximum capacity of approximately 40 min rolling off the mill. The storage racks are of cast iron with replaceable cast iron wearing strips. The mill is normally serviced by a single 50-ton slab handling crane but has available any one of four cranes in cases of breakdowns.

All five cranes in the slab yard use slab handling tongs which operate on the principle of ice tongs, see Figure 11. The craneman simply lowers the tongs centering them over the lift, drops the tongs to grip the bottom slab and carries it away for storage in either of the 1600-ft slab yards.

The crop disposal building placed side by side to the mill building is 432 ft-0 in. long, 64 ft-0 in. wide at crane rails and 32 ft-0 in. high from yard level to crane rails. Located in this building is a 30-ton crane for

use in handling slab butts, scrap, scale and spare parts. Also in this building are the settling pits, scale pit, waste water pumps, crop pit, auxiliary crop pit, truck unloading dock and space for mill spares.

WASTE WATER

The settling basins, scale pits, butt pits, railroad system and some of the basements are below lake level, and all waste water is collected in scale pits from which it is lifted into sewers. The pumping station consists of three 8000-gpm pumps, two of which are automatically controlled with the third acting as stand-by.

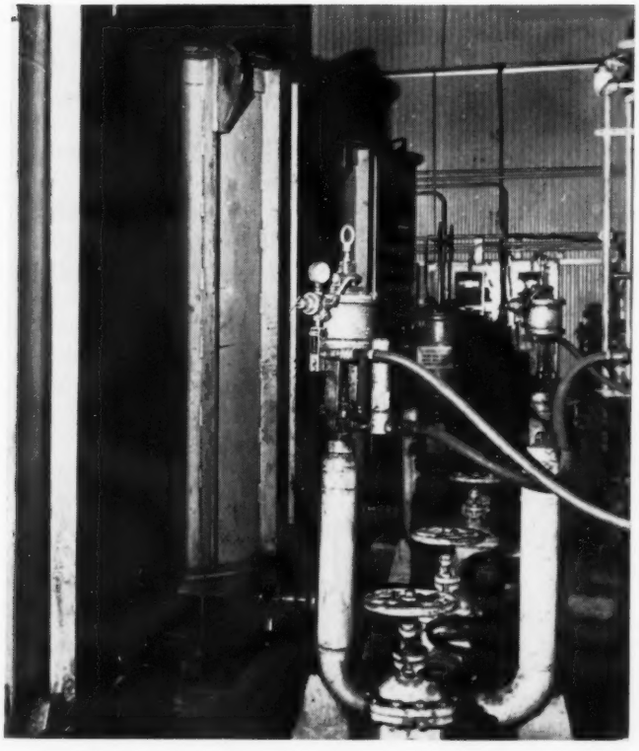
The pumps are electrically interlocked so that if the second pump kicks in due to high water all sluicing water is reduced to one half flow, and if the third pump kicks in due to flooding conditions all sluice water is shut off completely. In addition warning signals are sounded in the mill building, scarfer pulpit and roll stand warning operators to stop all water and cease operations.

COMMUNICATIONS

Communications within the department incorporate the following systems:

1. Three pneumatic tube systems, one connecting the entry end of pit building to the pit office, one connecting the pit office to the roller's pulpit and the third tying the pit office to the central providers office located at No. 2 open hearth.
2. Teleautograph system connecting the pit office and all operators pulpits.
3. Teleautograph system connecting the pit office to both open hearth strippers serving mill.
4. Four closed television circuits described in other portions of paper.

Figure 12—A central supply with three 4000-lb containers supplies grease for the individual mill systems.



5. All operators pulpits have inter-plant dial telephones.
6. Trolley phone systems on all cranes.
7. Two-way space radio between pit office and all mobile equipment in plant.
8. Intercommunication system between all operators stations.
9. The usual whistles, sirens and lights.
10. Private inter-departmental telephone system connecting the pit office and all operators pulpits.

PULPITS

All operators pulpits are of the most modern design with picture windows, air conditioning, sanitary facilities and drinking water coolers.

LUBRICATION

There are 11 heavy duty, motor-operated, time-clock controlled, centralized, pressure grease system units of the dual line pressure return type. Ten of these use an all purpose grease having an extreme pressure additive and serve all grease points in mill except screw splines, nuts, and pressure blocks on mill screws. The eleventh system serving these units uses SAE-250 HVY compound.

All ten units using the all purpose grease receive their grease supply from a common header, originating in the main grease house and running the complete length of the mill building.

This header consists of a 3-in. double extra heavy pipe having 1-in. drops taken off directly above and connecting to each grease pump reservoir thru a 1-in. high pressure valve and high pressure hose.

The grease is supplied to the header by high pressure, air-operated, transfer pumps from a manifold common to three portable grease containers each of which has a capacity of 4000 lb of grease illustrated in Figure 12. Grease may be transferred from any one of these three containers to the header by proper selection of manifold valves. The usual practice is to use grease from one container until it is empty at which time it is removed through the top of the house and transported to the refinery to be refilled. This operation is usually completed in 24 hr or less and eliminates the use of the many 55-gal drums generally employed in this service.

Since the header is under pressure at all times, the filling of a grease system reservoir is a relatively simple task of opening a valve and allowing grease to flow into reservoir. Each grease system reservoir is fitted with a low level limit which activates audible and visible signals when grease becomes low in reservoir.

In addition to the takeoffs for the individual grease systems, a riser has been added which extends to crane runway level and connects to spring-loaded high pressure hose reels. This provides for lubrication of cranes, eliminating the use of the usual pumps, containers and buckets.

LUBRICATING OIL SYSTEMS

The mill is furnished with two separate circulating oil systems. The vertical edger system is of the recircu-

lating spray type and supplies the edger screw gear train, edger adjust speed reducers, manipulator gear reducers and all points on screwdown except the splines, nuts and pressure blocks. Two 300-gpm pumps with 65-psi discharge pressure are furnished in the system with one operating and one as standby. Lubricant used is a 2400 SSU at 100 F oil. For this system three 6000-gal storage tanks are provided, two operating tanks and one reserve tank; all equipped with heaters and coolers to maintain proper oil temperature. The reserve tank is equipped with an automatic float switch controlling the shutoff valve in the event oil level becomes too high.

The table system is of the same type and lubricates all table drives and lineshafts except mill tables and the side-shifter car. This system is provided with three 300-gpm, 75-psi, pumps pumping 1800 SSU at 100 F oil. Three 10,000-gal tanks are used with one acting as a standby. All tanks are temperature controlled and the reserve tank oil level is automatically controlled. Rotary and magnetic type filters are used in each system. A centrifuge unit is also provided.

FUEL OIL SYSTEM

This system consists of a 100,000-gal reserve storage tank, oil preheater, three helical gear type pumps of 57-gpm capacity and a loop type 6-in. header which extends the full length of the pit building. At the extreme end of the loop, a relief valve is provided to maintain the desired pressure in the supply header for soaking pits and waste heat boilers. All oil lines are steam traced.

The fuel oil is supplied to storage tank by pipeline from a central pumping station. It is received at 210-psi pressure with a temperature of 180 to 220 F. The oil level is maintained at the required level by automatic float control. In addition, the tank is fitted with high and low level switches which activate a warning siren. Oil is withdrawn from the tank through an oil pre-heater to the helical gear type pumps which deliver it to the pit header at 145 to 220 psi pressure.

HIGH PRESSURE WATER SYSTEM

A high pressure water system, 140 psi, is provided for sluicing light scale from under all tables from mill runout to end of line. Three rotary pumps of 5000-gpm capacity take water from a 24-in. service water line and deliver it into the sluicing system.

APPLICATION OF MILL WATER

Mill sprays are fed from an 8-in. service water line remotely controlled by pushbutton from rollers pulpit. Similarly controlled is a 4-in. stand-by take-off from high pressure sluice line.

The top work roll is cooled by two 4-in. spray pipes connected by a common header which is fed by one 2-in. and one 1½-in. feeder lines. Wipers are used on the top roll to collect water which aids in cooling. The bottom roll is cooled by using 4-in. spray pipes fed by four 2-in. feeder lines. Vertical roll cooling water is supplied by same 8-in. remotely controlled valve, however a low pressure washing action is used rather than spray action.

Inland Steel Co. has been pleased with its automatic slabber. Slab quality is good, brought about by the inflexibility of the pre-punched cards. Consistency of sizes off the mill has been excellent. Physical fatigue to the operator has been reduced to the minimum. Wrecks due to human failure have been practically nonexistent. Breaking in of new men, by comparison, has been simple and tonnages have been good.

PART II—ELECTRICAL

by R. J. BEESWY*

Superintendent, Electrical Dept.,

Indiana Harbor Works

Inland Steel Co.,

East Chicago, Ind.

THE relatively new application of automation to the steel industry has been made possible by the advancement in electrical components and control systems. Automatic operation, such as that at Inland Steel Co.'s new slabber, is the major factor in meeting the demand for a higher quality product and the challenge of increased production. The following discussion covers the mill's electrical installation with particular emphasis on the experience and the problems which resulted from its construction, "shake-down" period and operation. Since many excellent articles have been published concerning the theory and design of the units to be covered, detailed analyses will not be included in this paper.

POWER SYSTEM

The slabbing mill was constructed as part of an expansion program which also included a new substation. A tie was then made with the lower power utility company. Power is transmitted to the substation by the utility at 138 kv, where it is stepped down to 13.8 kv and distributed to the slabbing mill and other installations in the plant. Load center, dry type, three-phase transformers are used in the motor room to supply 2400-volt power for motors, 480-volt power for lighting and motors, and 260-volt a-c power for two d-c rectifiers. The selection of different voltage levels for motor-generator set drive motors was based on company specifications which consider the combined cost of motors and spares and current manufacturers' standards. Generally, for 250 hp and below, 440-volt motors are used while for 300 to 2250 hp, 2300-volt motors were selected. Motors above 2500 hp are at the 13.2-kv utilization level. The two 1000-kw, 250-volt d-c pumpless ignitron rectifiers furnish all of the d-c power required for the operation, except that used for the adjustable voltage drives.

MAIN DRIVE EQUIPMENT

Figure 13 shows the location of the mill and edger main drive motors. The mill is driven by two 6000-hp,

* Now retired.

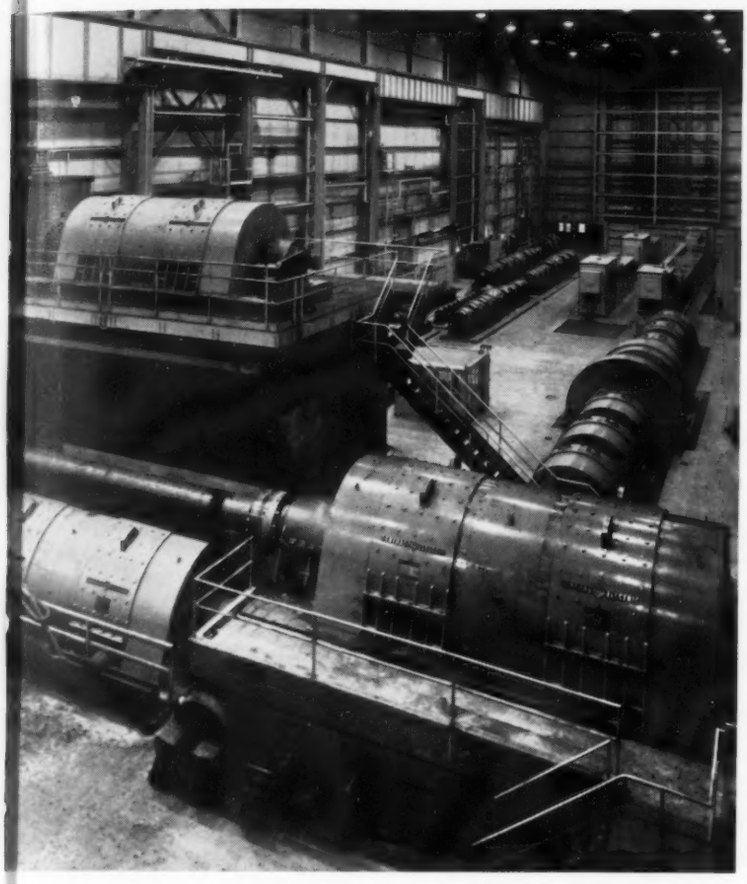


Figure 13—The mounting required for the edger motor did not permit use of a top motor forward main drive.

750-volt, double armature motors in a twin drive arrangement. Each 6000-hp unit consists of two separate 3000-hp motors bolted together through a forged coupling. The 4000-hp, 750-volt, edger drive motor is pedestal mounted, as shown in Figure 13, and consists of two 2000-hp motors also bolted together through a forged coupling.

The drive shaft extension for the top mill motor runs directly over the bottom mill motor and is supported by an "A" frame mounted bearing just beyond the drive end of the bottom motor. There have been other recent slabbing mill installations where the bottom motor is mounted below and behind with a drive shaft extension running under a forward mounted top motor. However, due to the design of our edger mill, its drive motor had to be so low that the pedestal on which it is mounted did not allow room enough for the top mill motor to be forward.

Quick response control for the main drives is obtained by the use of high gain voltage and load balance regulators, and 137 static switching units are used in place of the conventional sequential relays. Magnetic amplifiers are used to raise the control signal level of the static switches to a value sufficient to excite the required rotating regulators.

Main drive power is supplied by an eight-unit motor-generator set consisting of six 2500-kw generators and a 70-ton flywheel driven by a 10,000-hp, 13,200-volt, slip regulated induction motor. The motor-generator set is constructed so that any one unit may be removed without moving the others. Four generators are connected to a common bus with the mill motors. The other two generators supply the edger motor. A split bus arrangement for the main mill motors was tested during the "setup" period. However, the common bus arrangement proved to be more satisfactory for speed matching and is now in use.

Turnup and turndown of the slab is regulated by motor field control, which is set to give a slight speed mismatch at impact, resulting in the desired slab turnup. Shortly after impact, the load balance regulator takes over to correct the speed mismatch so that only a short portion of the front end of the slab is turned up. A chart of top mill motor current for several typical passes is shown in Figure 14.

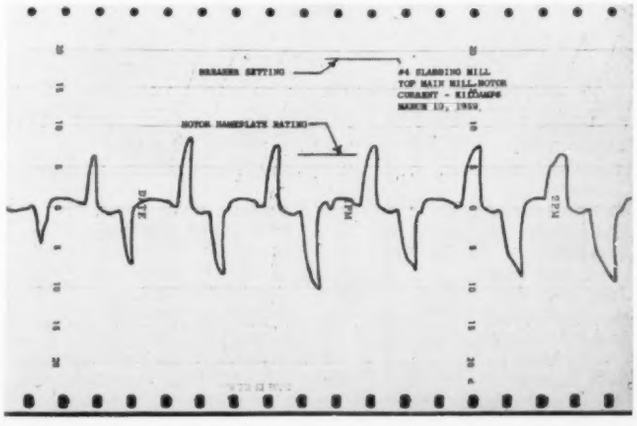
VENTILATION

The motor room basement is pressurized by drawing in outside air which is cleaned as it passes through a precipitator and filters. This air keeps the basement at a positive pressure, serves as make-up air for the main drive motors and motor-generator set ventilating system and supplies air for the blowers of the auxiliary drive motors. Holes were constructed in the floor around the load center transformers and under the auxiliary motor-generator sets so that the higher pressure basement air would pass up and along the side of the transformers and these motor-generator sets for cooling purposes. Blowers were selected in larger numbers of smaller units so that if any one blower is lost, sufficient cooling air will still be supplied. For instance, there are three 60,000-cfm blowers for the main motor-generator set and this set requires a minimum of 120,000 cfm of cooling air. There are also five 60,000-cfm blowers for the main drive motors, and two 108,000-cfm blowers supply the make-up air. All ten blowers use 60-hp motors and identical electrical controls. All of the auxiliary drives are ventilated through several nonrecirculating systems each fed by parallel blowers. The main drive motors and motor-generator set utilize a recirculating ventilation system. Basement air is blown into the machines opposite the commutator end, and blows over commutator to the filters which remove dirt and carbon dust. The air then passes through surface air coolers into the basement to be used again.

MILL AUXILIARY EQUIPMENT

There is a large degree of similarity between the

Figure 14—Top mill motor current often surpasses motor rating during normal rolling.



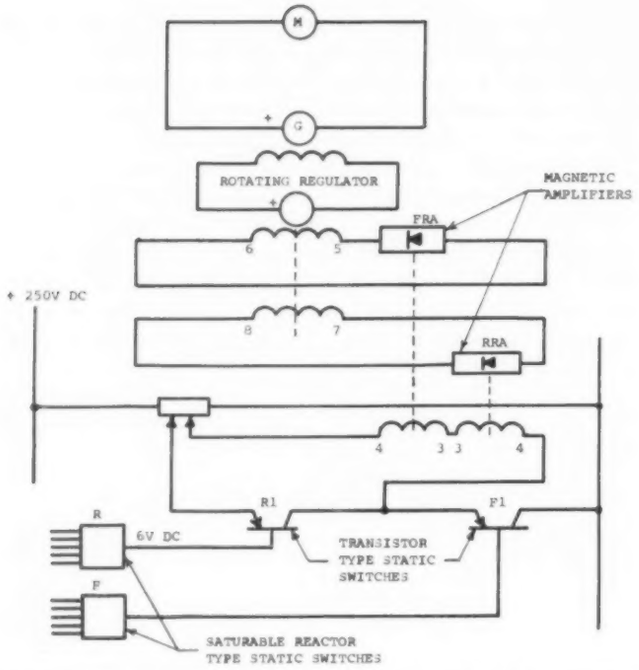


Figure 15—Saturable reactors and static switching is used in combination with high gain voltage regulators.

regulators for the mill auxiliary drives. Basically they are all high gain voltage regulators incorporating static switching and magnetic amplifiers. A simplified mill auxiliary control schematic is shown in Figure 15 and illustrates the use of saturable reactors and transistorized static switching as used in conjunction with the regulators.

The front and back mill tables consist of 14 rolls each, spaced on 29-in. centers. Each roll is equipped with anti-friction bearings and is individually driven by a special mill type, frame 616AEL, 25.8-hp, 79-rpm motor eliminating the line shaft and gearing. With these eliminated, it is expected that there will be fewer delays and that less maintenance will be required. There are two voltage regulators for the front mill table with every other roll drive being controlled by one of the regulators. The same arrangement is used for the back table. This should prevent downtime when rolling light ingots even if a regulator fails. These table roll drives are near their rated capacity when handling our largest ingot, which weighs approximately 22 tons and is 75 in. high, 79 in. wide and 30 in. thick. This is because on the first few passes with this size ingot only two or three table roll motors are being loaded at any one time.

The particulars of the main drive and the auxiliary equipment are shown in Table I.

TABLE I

Drive	Motors			Machine, maximum speed
	No.	Hp	Frame	
Horizontal rolls	2	6000	MCF	960 fpm
Vertical rolls	1	4000	MCF	960 fpm
Horizontal screw-downs	2	200	618AEL	600 in. per min
Vertical screw adjust	2	150	616AEL	12.5 fpm
Front table	14	25.8	616AEL	1000 fpm
Back table	14	25.8	616AEL	1000 fpm
Front feed rolls	2	25.8	616AEL	1000 fpm
Back feed rolls	1	25.8	616AEL	1000 fpm
Right side guards	2	200	618AEL	180 fpm
Left side guards	2	200	618AEL	180 fpm
Front fingers	1	150	616AEL	24 cycles per min
Back fingers	1	150	616AEL	24 cycles per min

PROGRAMMING EQUIPMENT

Programming is advantageous because mill and edger speeds may be preset so that edger drafting may be performed in both directions and initial acceleration is always at maximum torque.

As a unit, the components of the program control equipment present a rolling plan, in the form of electrical signals, that will be followed for the reduction of a particular ingot. The numerical type program control, using punched cards as the information source, basically contains three types of units. These are: (1) the card and card reader, (2) the position sensing devices and (3) the master program control and position regulator panels. Figure 16 shows a block diagram of the entire control system.

The card reader has two reading heads in tandem and is a brush type unit. Either one of the two heads may be selected to perform the reading operation. The card reader reads one half of one row at a time with all parts in a static condition. This removes the need for extensive memory units, gives very reliable readings and permits the programmed data to be stored in the card. In order to do this, about 2500 wires are brought out of the card reader. To date no failures have occurred in the reading circuits. We have, however, experienced a few failures with the card feed mechanism. These resulted primarily during the first month of operation and for the most part could be attributed to torn cards. After the card carrying clips and spacers were realined, the fault was virtually eliminated. The cards must be kept dry and free of dirt and oil for good performance. The card reader is mounted in the roller's pulpit which is air conditioned and supplied with filtered air. The reader is inspected and cleaned weekly by an outside specialist in this field and is the only piece of electrical equipment in the mill which is worked on by other than our Inland personnel.

Three types of position sensing devices are in use. These are: (1) selsyns, (2) hot metal detectors and (3) limit switches.

There are three ganged selsyns used as feedback units for both the mill and edger roll openings. On either unit the selsyns are geared such that there is a high, a medium and a low speed signal as a result of any screw movement. These signals are compared to a reference signal and mixed to give one composite signal. When a signal null is reached, the screw movement is stopped. Roll opening tolerances are $\pm \frac{1}{8}$-in. for the mill and $\pm \frac{1}{4}$-in. for the edger. The tolerances are not quite satisfactory and will be reduced by adding a higher speed selsyn to both of the feedback units.

Ingot and slab positional information for the program control is obtained by the use of hot metal detectors. The hot metal detector is a solid state "electronic" device which is photo-sensitive to infrared radiation. Whenever any infrared radiation impinges on its surface, a small voltage is produced which is then amplified to the level required for an original input to the program control center. Since very little was known about the

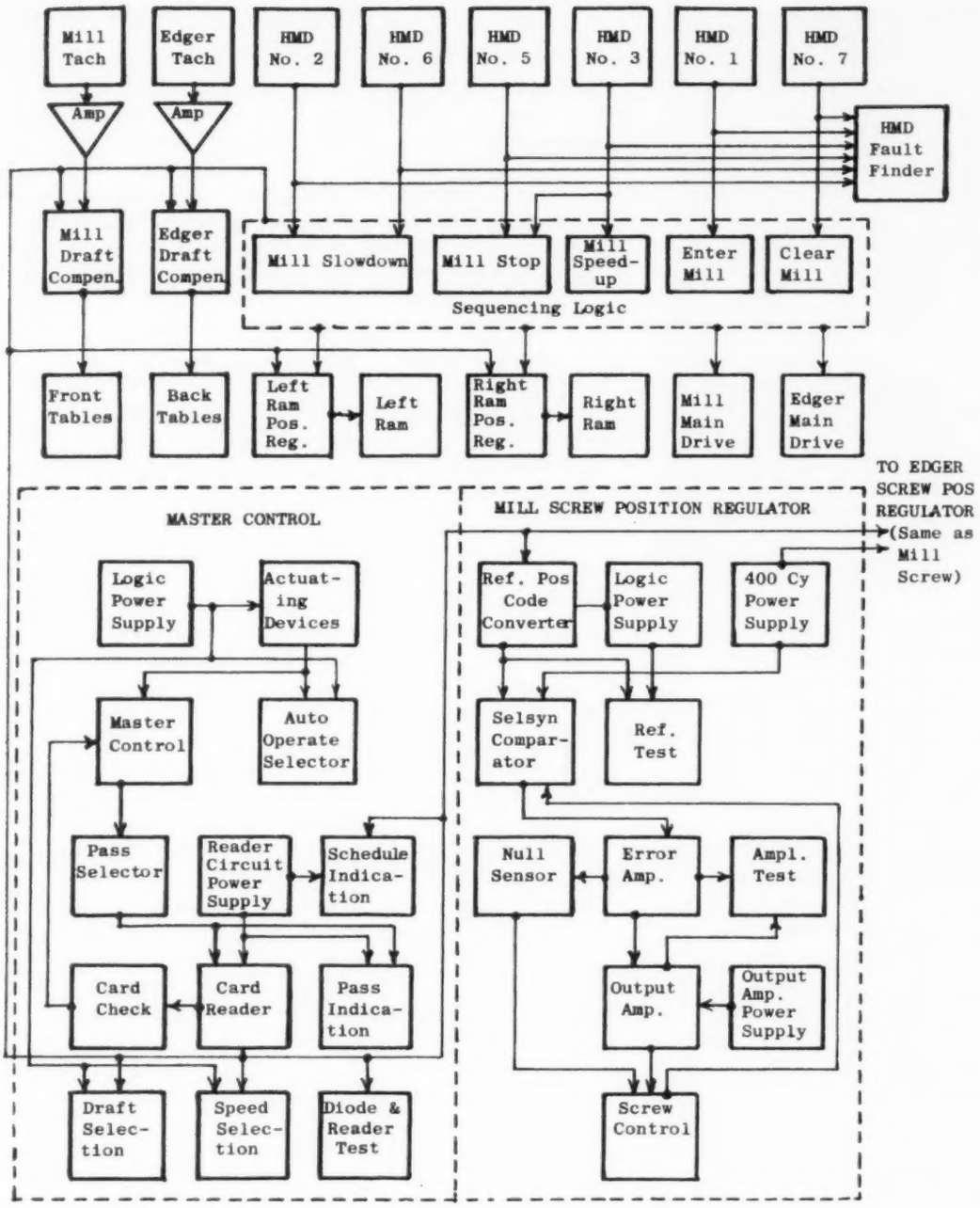


Figure 16—The program control system presents an electrical signal rolling plan for ingot reduction.

industrial use of hot metal detectors, several units were tested on a blooming mill in the plant prior to the construction of the slabbing mill. Testing indicated that the lenses on the units had to be cleaned every 24 hr if successful operation was to occur and that the unit had to be mounted approximately 12 ft above the mill table to prevent damage from overheating. It was decided that a jet of air should be directed across the face of the unit to prevent dust and dirt from collecting on the lenses. There are two detectors operating in parallel at each position and a visual indicating fault finder is located on the program control panels to show hot metal detector operation. To date there has been one hot metal detector failure.

Limit switch position sensing is a straightforward operation that simply disconnects the reference signal to the given drive's regulator when the proper position has been reached. Snap break, multicircuit, cam type limit switches are used for these operations.

The main program control center consists of encapsulated units, necessary power supplies, metering and monitoring equipment and trouble-shooting circuits. The encapsulated units are saturable reactor type static switches, transistorized static switches, transistorized amplifiers, mixers, discriminators and interposing relays. There are more than 1500 of these encapsulated units in use when including the main drive and auxiliary regulators. Vacuum tubes are not used in any of the control. A view of the program control panels is shown in Figure 17.

INGOT BUGGIES

Two cable driven, automatically-positioned ingot buggies with motor driven table rolls for unloading are used to deliver ingots from the soaking pits to the mill. The cable reels are driven by frame 620AEL, 275-hp motors, and the maximum speed of the buggies is 1200

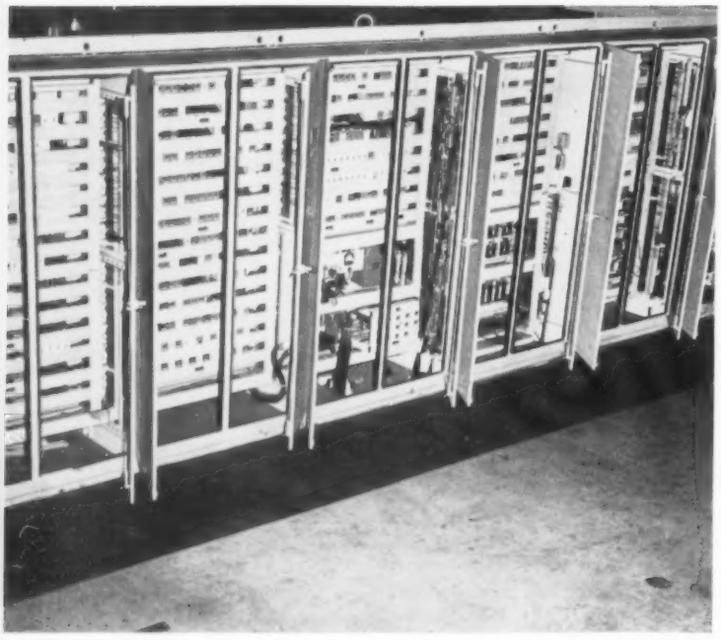


Figure 17—The program control panels are encapsulated units, containing trouble-shooting circuits.

fpm. Figure 18 shows a layout of this system. Automatic positioning at a particular pit is accomplished by setting up a predetermined reference voltage with a selector switch. This voltage is cancelled by a signal from a selsyn receiver driven rheostat. The initiating input comes from a selsyn transmitter which is geared to the cable reel. The control is an adjustable voltage system utilizing magnetic amplifiers for the preamplifying stages. When traveling in a given direction, the front motor pulls and the back motor acts as a drag generator so that the cable is always under tension. In the event of a cable failure or a fault that results in a slack cable condition, the motors are immediately de-energized and their electrical brakes are set. At the same time a mechanical brake is actuated if the buggy is traveling toward the mill.

COMMUNICATION EQUIPMENT

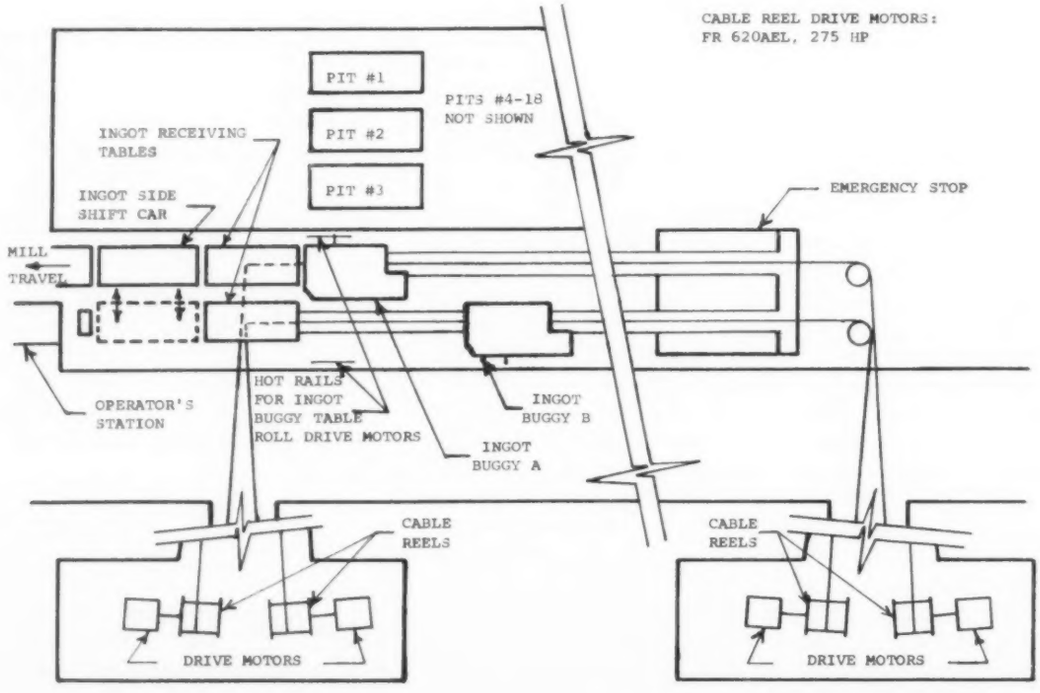
Modern communication systems, such as closed circuit television for monitoring purposes, automatic weighing, recording and totalizing equipment, are in use throughout the mill. This equipment is maintained entirely by plant personnel. The intercommunication system includes numerous sending and receiving stations throughout the mill so that all operating stations and other strategic positions are interconnected. A teleautograph system and several pneumatic tube message carriers are also in use.

OPERATING EXPERIENCE

Complete automation of the mill operation was a particularly difficult problem because it was our first undertaking of this type. Even though a great deal of effort was put forth in the design of the electrical system, many field changes, adjustments, additions and deletions had to be made. These were accomplished through the combined efforts of the manufacturer's representatives and company personnel.

Automatic manipulation of the ingot or slab has proved to be the greatest problem and at this date still has a slight time disadvantage. Manual manipulation is still as much as three sec faster per 90-degree turn than the automatic mode. Although this may seem to be a very short period of time, when based on the present practice of one 90-degree turn per ingot and a 100 to 120-sec total rolling period, a two to three per cent increase in production may be obtained by saving the three sec. More rapid manipulation in the manual mode is the result of the operator's ability to anticipate the slab or ingot position throughout the entire manipulation procedure. Although considerable effort has been directed to repositioning sensing devices, circuit redesign, and fine tuning, the automatic mode is still slightly slower. A program of changes will soon be initiated that should result in an automatic manipulation procedure that will be more rapid than the manual

Figure 18—Reference voltage determines the positioning of the ingot buggies at a preselected pit.



operation. This method will essentially involve new circuits and sensing devices that should result in cycle anticipation.

Originally tandem rolling was difficult on semi-automatic operation because of separation of the ingots during the passes. This has been fully solved by the installation of a selector switch that allows the operator, when he finds it necessary, to control the mill from a foot master switch and the tables from a hand master switch. There also was a period early in the operation of the mill when the main motor-generator set slowed down on tandem rolling of long slabs, resulting in excessive generator field forcing to maintain voltage. This situation was alleviated by retuning the slip regulator for the main motor-generator set induction motor. Prior to the purchase of the mill, computer studies were made to calculate the size of the motor-generator set flywheel. Additional studies are being made to determine the extent of the usefulness of the flywheel for this reversing mill when rolling tandem.

The mill horizontal screwdown brakes have caused some difficulty. There are three, 23-in., NEMA, magnetic brakes on the screwdown and these brakes are located directly above the front of the mill. Steel dust accumulates in these brakes and causes incomplete opening which results in rapid brake shoe wear. A brake modification, initiated by one of the electrical maintenance men, has been made by drilling a hole in the torque adjustment nut. Forced air is then applied to the brakes through these holes whenever the brake is de-energized. This air blows off the steel dust, cools the wheel and has alleviated most of the difficulty. However, the brake adjustment and operation is still extremely critical because there is a small amount of screw backup at impact if the brakes are not alined perfectly and set with maximum pressure on the wheel. This would seem to be a challenge to mill builders, as the brakes should not have to hold the screws at impact.

Experience to date indicates that the operation and life of the electrical equipment will be excellent. The use of the saturable reactor type of static switch has resulted in practically no failures and it seems to be very rugged. Faults, however, have occurred in the transistorized static switches and solid state diodes. Generally the fault takes the form of a leak or an incomplete cutoff of the transistors. When a transistor switch fails completely, the fault generally occurs shortly after the unit has been placed in service. The germanium diodes are very sensitive to overvoltage and heat and have failed on numerous occasions, particularly in the magnetic amplifier circuitry. All of the germanium diodes in the magnetic amplifiers are presently being replaced with less heat sensitive silicon diodes.

Fault finding circuitry is built into the master program control so that isolation of a major control section failure may be accomplished very rapidly. In addition, most of the static switches contain individual monitor lights, and test points are brought out of the encapsulated amplifiers, mixers and discriminators. These have proved to be very effective troubleshooting aids. Although faults have been few in the program control panels, power supplies and complete plug-in type spares, consisting of a number of potted units, have been equipped with extension connections. This allows whole sections of the system to be replaced very rapidly. The faulty section may then be removed with a minimum of mill downtime and repaired in the mill or meter shop.

In step with our normal plant preventive maintenance procedures, a program of cleaning, testing and adjusting all of the system components is followed during each mill downtime by the assigned maintenance personnel.

LIGHTING AND WIRING

Inland Steel Co. developed overhead lighting for the mill and motor room is accomplished from a 480-volt, 60-cycle source with individual ballasts and 1000-watt mercury vapor lamps. Each lamp is equipped with an individually fused safety switch just ahead of the lamp and ballast. The safety switch is completely accessible to the individual when in position to change either the lamp or ballast, making it a safe one-man operation. Since the average lamp life is already well in excess of 10,000 hr as compared to the former 1000 to 2000 hr for incandescent lamps and lamp replacement requires only one man, the installation is resulting in substantial savings. Staggered among the mercury vapor lamps are incandescent lamps for emergency lighting, and there are also wall-mounted battery units for the same purpose. Illumination at mill floor level is equal to 18 ft-candle.

Wherever physical conditions permitted, cable tray was used in place of conduit. Along with the trays, multiconductor cable was used extensively for both control and power wiring. Approximately 3,000,000 ft of wire is installed in the mill.

ELECTRICAL MAINTENANCE PERSONNEL

Selection of electrical maintenance personnel to maintain a mill as electrically complex as this posed a major problem. However, because the mill constituted a portion of a major expansion program and bargaining unit seniority is established in individual mills only, there were no past practice precedents to hinder the development of job descriptions and a new sequence. An organizational chart is shown in Figure 19.

With the advent of the electrical equipment in this mill, it was apparent that new qualifications had to be established for electrical personnel because the equipment requires a great deal of electronic and instrument maintenance and repair as well as the regular motor inspector work. Rather than use specialists in each field, a job classification of electrical technician was developed that embraced all the necessary skills. This move has successfully eliminated any difficulties concerning which work should be performed by a particular specialist. There is also a new classification of electrical control operator which was put into effect, rather than a motor room operator classification, so that there would be no restrictive work areas. These changes gave incentive to good men and a more flexible maintenance organization resulted. Selection of personnel was accomplished by screening all highly rated applications submitted by plant personnel and others. Particular attention was given to the graduates of the two-year Purdue-Inland

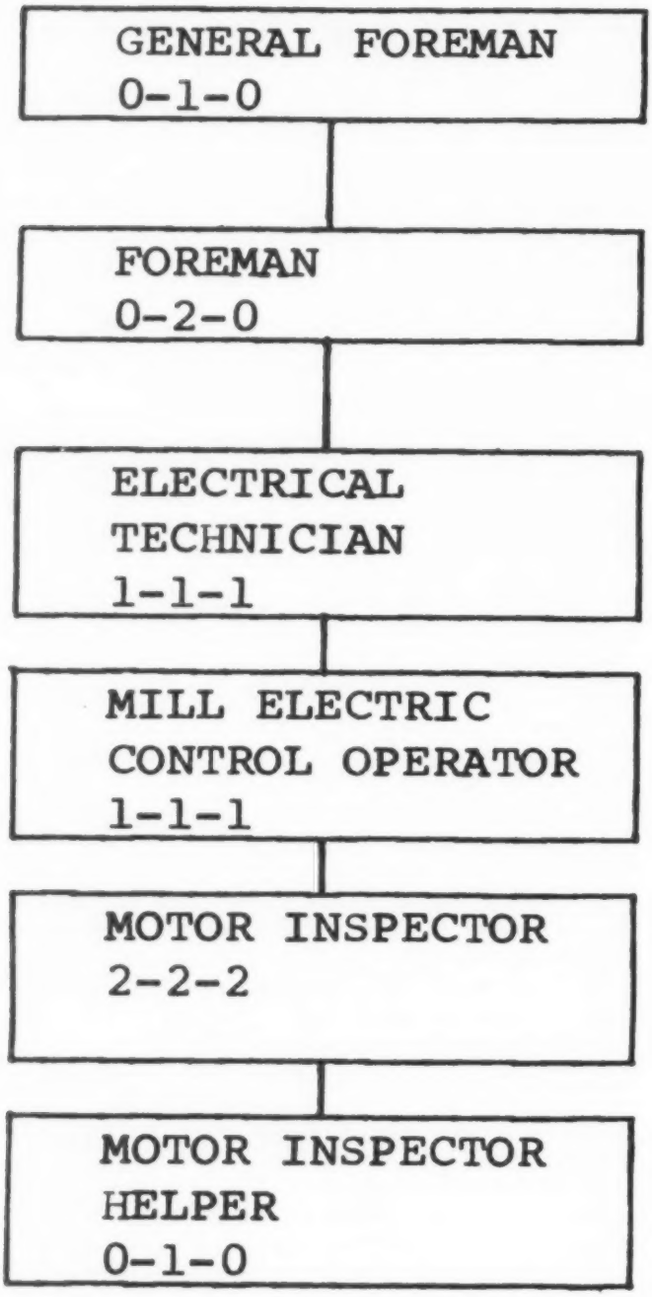


Figure 19—Development of new job descriptions and sequence permitted utilization of specially trained personnel within the organization.

electrical course and those with other types of special training.

The complexity of the equipment necessary for automation accentuates the need for extensive training programs. This is a field that we have been vitally interested in for some time. After all, millions can be expended to install an automatic installation, but it may be a bad investment if there are no technically qualified people prepared to perform the required maintenance. It is no longer possible to overpower breakdown situations with a large force because the failure may be anywhere from the card reader to the drive motors and only with an intelligent trouble-shooting procedure can a fault be isolated and corrected with a minimum delay. The gap from magnetic control to that of static switching and solid state electronic circuitry is large because the visual trouble indicators that were formerly available are no longer present. Several efforts have been made by our organization to prepare for this era. One of the most successful of these is a joint program sponsored by Inland and presented by the Purdue University that offers a two-year, off-work, series of technical courses. Both steel industry management personnel and educators can make considerable contributions toward a more efficient steelmaking operation by the further development of technical training programs.

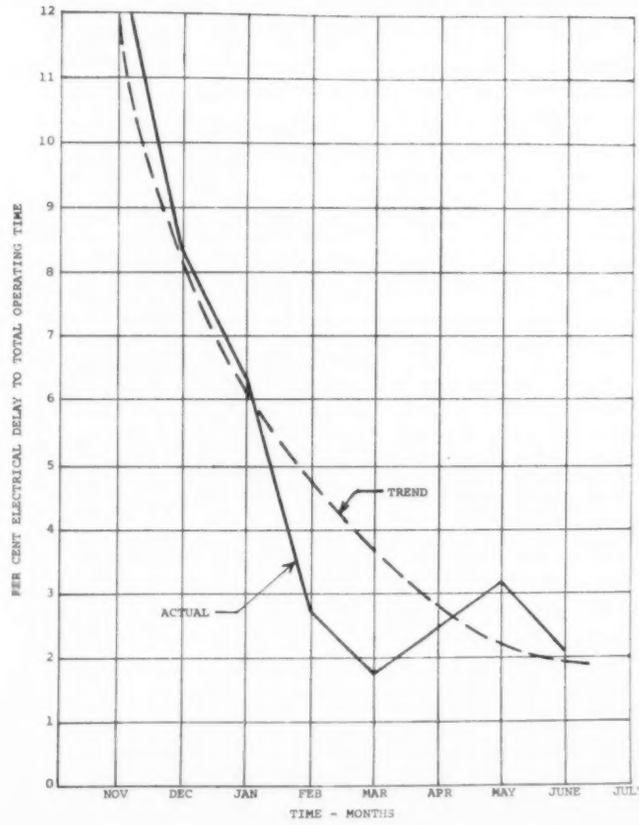
The electrical technicians were placed on the job one month prior to mill start-up, and the remainder of the bargaining unit personnel were assigned one week later. Since this time a series of on-the-job training classes conducted by the slabbing mill electrical foremen have exposed all of the mill maintenance crews to the particular circuitry and electrical equipment involved in the mill operation.

During the installation and start-up period, a foreman from the electrical supplier, two electrical foremen and four engineers worked with the manufacturer's representatives and also assisted in the training of new men. Now that the mill is in operation, there are four bargaining unit electrical maintenance men working per shift. In line with existing plant policy, the general electrical foreman and electrical foremen perform as supervisors during the day turns only, except in case of emergencies.

SUMMARY

As more experience is gained with this new installation and as modifications are completed, the function-

Figure 20—Decreases in downtime due to electrical delays are attributed to the electrical refinements and experience.



ing of the electrical equipment should be even better than it is presently. Figure 20 shows a graph of electrical delays which indicates the results accomplished by the electrical refinements and more experience.

In general, the operation of electrical equipment used for programming, controlling and driving the mill has proven very satisfactory. Much of this success is attributable to the manufacturer and their designers. Productivity increases and a higher quality product have resulted from this move to automation and the experience gained in meeting this electrical challenge should serve well to prepare us for even greater advances in the future.

Discussion

PRESENTED BY

R. B. ALLARD, Superintendent Primary Rolling, Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit, Mich. (Now retired)

E. R. MC GAUGHEY, Superintendent, No. 3 Bloomer and No. 4 Slabber, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

M. F. DEMSHAR, Superintendent, Primary Mills, Acme Steel Co., Riverdale, Chicago, Ill.

W. J. TUNNY, Superintendent Electrical Maintenance, Indiana Harbor Works, Youngstown Sheet and Tube Co., East Chicago, Ind.

R. J. BEESWY, Superintendent, Electrical Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind. (Now retired)

T. HARMON, JR., Chief Electrician, Granite City Steel Co., Granite City, Ill.

JOHN H. GREINER, Supervisory Engineer, Metals Industry Group, Industrial Equipment Div., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

R. B. Allard: You state you have relocated the number three hot metal detector to the centerline of the mill. Can you furnish a more specific location of these detectors in relation to the mill housings?

Do these hot metal detectors require any maintenance, and if so, how much?

In Figure 2, describing your pulpit layout, you mention indicator lights which furnish finished slab size. How do you take these measurements?

E. R. McGaughey: We changed the location of the No. 3 hot metal detector to the centerline of the horizontal mill rolls. Originally it was positioned on the entry side of the mill controlling the entry and the slowdown and reversing and so on. No. 4 detector performed the same function on the delivery side of the mill.

The No. 3 detector is now located about 12 in. beyond the end of the rolls with the detector looking at a target point approximately 2 in. above the working face of the bottom roll. In this position it is fairly well protected from dirt, fumes, heat, steam, etc., which affected its operation while in the higher position directly over the table line.

The detectors do require maintenance. In addition to a glass shield, we have also installed heat shields with very small slots in them to minimize the amount of dirt settling on the glass, and we inject clean air across the face of the detectors.

However, with all of this they still require cleaning once each turn.

The indicator lights referred to merely inform the roller of what finished slab section the data card in the card reader is asking for and has nothing to do with automatic measurement of the finished slab.

Member: We suppose you probably have much paper work in rolling steel as we do and we know you have a system of moving it quickly. We have put in a similar system in that we teletype our orders to the mill and after distribution in the pit, the order is teletyped to all the offices in the mill. The rolling information is picked up and is an exception in that it is done manually. The second step of the system will be to pick all up automatically so that there is no recording on the mill and we pick up then the printed card, bill our customers and go ahead with our standard cost system and information from that card. With the increase in mill speeds it is important that we have the papers going at the same rate.

Have you established a maximum size reduction for some representative range of your ingots?

We recognize the advantage in using television at the shear when you are rolling top first. We would like a little information from you on the advantages you may be realizing. You make a point of weighing all your ingots and printing it up very fine for the end of the term, we would like to know whether you use that for control purposes.

Are you making progress on tandem rolling?

One significant difference between your mill and ours is in the shear area, in that we have a down-cut hydraulic shear and that is a real point to consider on these fast mills. We had it ranging up to 24 in. whereas your range is up to 12 in. or so. It appears that the shear may be a bottleneck for these high rates we are going to experience. Are you using the shear fully as an up and down cut or are there problems of adjustment when it is necessary to use it as an up-cut only?

On the layout there are no turnarounds on slab removal cranes from the mill. What you think of that or do you have a turnaround some place where you can criss-cross your filling?

E. R. McGaughey: On the maximum edge reduction we have set as one of our basic criteria 1½ in. maximum draft on the edging mill.

As for maximum and minimum ingot to slab reduction, our limits are 18 in. and 5 in. respectively, however, in actual practice the maximum reduction is often exceeded by 5 or 6 in.

In regard to the television at the shear, perhaps we had better explain several items. The television at the shear that we use for crop shearing has worked out fairly well. At present some refinements must be made to give the kind of a job we actually want.

We do record our ingot weights, but this is strictly for inter-departmental purposes at this time. We have hopes that in the future we will be able to use these recordings to establish ingot to slab yields.

Tandem rolling has been much more successful on

the automatic slabber than has single rolling. Automatic tandem rolling of comparable sizes is much faster than the semi-automatic method.

The speed of the shear was very vital to us. We went into this particular problem quite thoroughly during designing and engineering, recognizing that we were building a mill from which we expected high tonnages, which meant a fast operation, particularly so when tantem rolling.

The shear has a maximum opening of 16½ in. and is capable of shearing 900 sq in. By making several mechanical changes and using larger motors we increased cutting speeds from 8 to 18 cuts per min which we feel will be adequate.

We are using the shear as an up-down cut and although we have not found it necessary as yet to use it as an up-cut only, we would say to do so simply means blocking the top head mechanically.

I am not quite sure whether you referred to the turning of the slab lifts or the turning of the ingots. We have no turnaround means in our slab yards for turning slab lifts so we lay all of our lifts down parallel with the crane runways across skids. It has worked out very satisfactorily as far as we are concerned.

As for turning of ingots, we simply deliver our ingots to either one end or the other of the buggies, depending on how we choose to roll the ingot.

M. F. Demshar: In comparing your mill with Acme Steel Co.'s bloomer the ingots you roll are wider than ours are tall. You roll more tons in one hr than we roll during an entire turn.

You apparently take much extra soaking pit time which definitely improves quality. You take extra passes in your mill which does not do any harm. There is no reason to believe that the melt shop makes any effort not to divert bad heats to one of your older blooming mills.

Do you have enough cost experience on your conditioning and rejections, such that you might say that later on, when you reach a production pinch, your present practices will justify what we might call slow-rolling for quality performance? At other mills, we have sometimes heard remarks about 6 in. drafts; yours are 1½ in. However, maybe your bloomer will always be ahead of the re-rolling mills, and it will not be necessary for you to speed up your rolling.

The next area is in your verticals. You have successfully made your verticals work in both directions. In our opinion, this is quite an achievement! Do you have ragging on your horizontals or on your verticals? If not, do you contemplate putting any ragging on either?

You mentioned that your slippage runs from three and a half to seven per cent which is 100 per cent variation. Have you rolled any of the higher carbons on this mill or any alloys? If you do, do you see any need for different punch cards to compensate for the different spreads and slippages?

E. R. McGaughey: Drafting on the mill with regard to quality demands depends on a great many things, several of which you mention in your question. Our feeling is that we shall continue to use the lighter drafting until such a time when we cannot meet the demands placed upon us for more tonnage. As for cost experience, conditioning costs versus tonnage, the picture changes considerably from time to time depending on the press of business and a true analysis cannot be made today of a situation that may occur six months hence when tonnage demands could be either extremely high or low.

We have no ragging of any type on either the horizontal or vertical rolls and at the moment can see no practical reason for using it.

Considerable work was done on slippage in the mill prior to punching our first set of cards. Not being able to establish a definite factor from our experiments, an arbitrary figure of 5 per cent was used and has worked out satisfactorily to date. This figure seems to be practical enough in our operation and compensates to a large degree for the many variables encountered in our particular installation. We realize, of course, that certain refinements might be necessary if and when the mill is required to process the higher carbons and alloys.

W. J. Tunny: Will you explain more fully why the 70-ton fly wheel has not proved its usefulness on the motor-generator fly-wheel set?

What provision do you have for ground detection for the electrical main drive equipment?

What kind of individual overload protection do you have for the table motors?

R. J. Beeswy: With regard to the main motor-generator set fly wheel problem, the slip regulator was set at 170 per cent to prevent slow down on tandem rolling. This has caused no problem to the public utility in that our Scherbius tie is load regulated to the utility.

Ground detection on the main drives is by a selector switch connecting a high resistance voltmeter to either positive or negative and ground.

Standard overload relays protect the individual table roll motors, however this relay opens the "m" contactor for that motor rather than the "uv." With this system the other motors on the same generator are not affected.

T. Harmon, Jr.: Mr. Beeswy made the statement that he has been successful in regulating the turn-up or turn-down of the slab by having the motor speeds mismatched at impact. If he cares to let us know the secret of this we would certainly be grateful as we have not been successful with this procedure. We have mismatched speeds from an infinitesimal amount to a considerable degree. We found that the pass line has much more of an effect than speed mismatch of the roll drive motors.

On your ventilating system you speak of filters to remove the carbon dust after the cooling air passes over the commutator. Is the motor and generator ventilation a closed system or is the air dumped into the motor room before being recirculated?

You mention that you can use your edger with preset draft in both directions. How often you do edge in both directions?

You have experienced some difficulty with the card reading mechanism. Have you given any thought to replacing the card equipment with a magnetic tape system?

The top speed of your ingot buggy is listed at 1200 fpm which is rather rapid. What is the amount of time you are actually operating at this speed before going into slowdown?

You mention also that you had to retune your slip

regulator for the long passes when rolling double ingots. By this we assume you mean that you are allowing your motor to take a considerable amount of power from the supply lines in order to maintain speed. Has this affected your charges from the utility company to any great extent? We wonder if in the future we should do away with the fly wheel sets and use synchronous motors if we are going to bigger slabs with the subsequent longer passes.

In regards to the trouble you have had on the screwdown brakes we have managed to decrease our troubles on these units by the use of covers. On this point we wonder about the pitch of your screws as we have not experienced much trouble with our screws backing up. Have you increased the pitch in order to get a more rapid response?

You seem to have cleared a major hurdle with the bargaining unit in work assignments and selection of personnel. Of all your secrets this is the one that would interest most of us because it is probably the toughest one we have to solve. In the opposite direction did you experience any difficulty in selling top management on the number of electrical personnel and your proposed maintenance program?

Has this control system eliminated or decreased the time required to transfer from armature voltage to field control on the way up and vice versa on the way down?

R. J. Beeswy: Slab turn up or down is done by mismatching the no load speed of the motors by decreasing field current on one of the motors. Only the first foot or so of the slab is turned up or down because of the load balance system.

The ventilating system is a closed system with air entering the back of the machines and out over the commutator, through oil impregnated filters, cooling coils and back to the machines. Outside make up air is furnished to this system and to pressurize the motor room.

It is regular practice to draft the edger in both directions.

We have given no thought to replacing the card reader with a magnetic tape system.

It takes 30 to 35 ft to accelerate and stop the ingot buggy, top speed is maintained over the rest of the travel.

The mill screws are standard pitch and have not been changed.

The bargaining unit people were hand picked as this was a new department in a new area. We had very little difficulty selling management on the electrical personnel or maintenance program.

The time required is only limited by the capability of the motors, not the controls. We experienced no difficulty in setting the controls to the minimum reversal time of the motors.

John H. Greiner: Of particular interest was the tandem rolling and its problems. We have seen this practice several times about 10 or 12 years ago, but cannot remember seeing it lately. Just how common a practice is tandem rolling and to what extent is automation used here, particularly on manipulation of the ingot or slab?

We would like to say that you are not alone in your problem of screw backup at impact. We have seen blooming mills, with a total of three brakes, move as much as $\frac{3}{8}$ to $\frac{5}{8}$ in. When you are seeking close tolerances on your product, this can get to be a problem.

E. R. McGaughey: The amount of tandem rolling varies greatly from month to month and depends largely on duplication of orders. We will tandem roll from 40 to 60 per cent of our total tonnage.

Full automation has been quite successful in this area except for the manipulation, which is done manually. As of this date automatic manipulation cannot match manual turning, time-wise. We hope this facet of rolling can be improved upon at some time in the future. ▲

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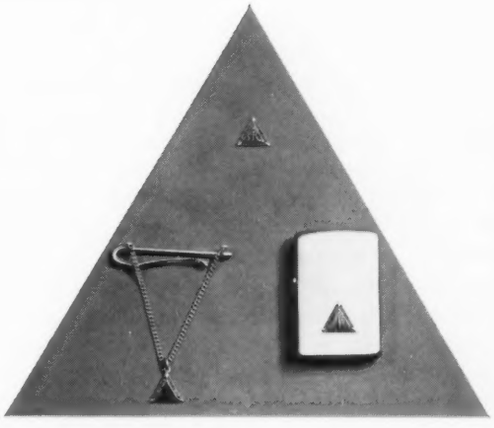

ASSOCIATION OF IRON AND STEEL ENGINEERS

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Maintenance of

MAINTENANCE of electric power equipment in a completely integrated steel plant involves a wide range of problems including almost all kinds of both rotating and static equipment. This paper delves into some of the general considerations common to all equipment: safety, inspection, records, cleanliness and insulation testing; and such specific problems as rotating equipment, rectifiers, oil and air circuit breakers, transformers, lines and relays.

Work on electrical circuits and apparatus is generally considered hazardous. Therefore, the primary responsibility of persons engaged in power work is to see that proper safety considerations have been taken to insure the welfare of all personnel before any work is done on equipment. This can only be done in one way. Strict and sensible rules must be drawn up and adhered to without deviation. There are many different safety regulations on all types of power systems. This is as it should be because there are no two power systems anywhere the same. Consequently, safety rules must be drawn up to cover each specific system. All the rules, however, should arrive at the same result—to make it impossible for anyone to be injured in any way. This may sound like a strong statement but in power work a man is extremely lucky if he gets a "second chance." The next step after drawing up the safety rules is the education of the maintenance personnel in these rules, after which the rules must, of course, be enforced. A safety regulation written in the book is of little value if it is not understood and followed. It is a costly and lengthy job to educate personnel in the safety considerations that must be taken on all jobs, but nothing pays higher dividends. There are, unfortunately, infractions of safety rules; this is where enforcement comes in. There are many different ways to penalize men but the primary objective should be to make them realize that management will not, under any conditions, tolerate safety infractions. If regulations are drawn up, adhered to, and enforced, the safety program will work and the primary responsibility of the power maintenance personnel of insuring the safety and welfare of everyone concerned is then a simple and rewarding task.

The beginning of any good preventative maintenance program has to start with a systematic, periodic and competent inspection. Periodic inspection can be accomplished by establishing a strictly adhered to routine schedule. Sometimes this becomes difficult since operating personnel often seems to place production ahead of maintenance. Experience has shown, however, that persistence on the part of the maintenance personnel usually pays off and in most cases the equipment can be shut down at its periodic time for inspection. This schedule should, of course, be made to fit into operating procedures.

Competent inspection involves getting the right man in the right job. People whose job it is to inspect equipment are usually men who have worked up through the lower job classifications to this position of responsibility. It takes a certain type of person to go into a location and carefully check all the different variables necessary to do a thorough inspection job. The inspector must have a thorough understanding of the apparatus as well as pride in his ability to do a good inspecting job. When a man like this is found, he is extremely valuable.

After the inspection is completed the information obtained should be recorded in detail so that it can be compared with previous results and proper action can be taken when necessary. Proper records can "make or break" a preventive maintenance program. In any fair sized power system, there should be a clerk whose job it is to maintain records. Records properly filled out, filed and kept up to date make it easy to keep a running inventory of spare parts, replacement brushes and many other items that a maintenance man must have on hand and know where they are. It is a very bad feeling during a breakdown not to have a required part available. Conversely, there is satisfaction in being able to go to a good file and find within a few seconds that a part is available, and where it is.

Up to date, properly filed records are also invaluable in determining the condition of equipment. Insulation tests and oil tests, for example, can reveal a slow deterioration and trouble can be prevented by picking the deterioration off on a properly kept file. Colored tabs on cards make it easy to determine the last time a piece of equipment was inspected or serviced and, if servicing falls behind, they are a constant reminder to take the necessary steps to bring the schedule up to date. Maintaining proper records is a full time job. Nevertheless they are an extremely valuable tool in a preventive maintenance program.

Electric power equipment, to give the best service, should be kept as clean as possible. This is extremely difficult in some locations. In these dirty locations maintenance personnel must be very thorough in the maintenance program. Dirt, oil, acids, gases, etc., all adversely affect electrical equipment in many different ways. The best practice is to study each installation carefully and install cleaning equipment to keep all these harmful elements away from it. Where this is impossible or economically not feasible, each location should be studied individually and a schedule for inspection and cleaning set up. When equipment gets dirty, it can be cleaned by many methods, such as blowing with compressed air, drawing with suction, by wiping, washing with solvents, etc. Testing should be done periodically to determine the thoroughness of the cleaning program.

Insulation tests should be periodically run on all equipment and carefully recorded. Maintenance of satisfactory insulation levels on electrical equipment is one of the maintenance personnel's chief responsibilities. When insulation fails, it usually involves a lengthy and costly shutdown. Under a good testing program, deterioration can be picked off and necessary steps taken to rectify this condition, thereby, keeping insulation failures to a minimum. There are many kinds of insulation tests such as megger, a-c and d-c potential tests, electrical absorption tests, etc. Each test has its

Electric Power Equipment

own advantages for different locations and type of equipment. Regardless of the type of test, if it is faithfully carried out and studied, it is a very helpful tool to the maintenance personnel in maintaining proper insulation levels.

Transformers are probably the most reliable piece of electrical equipment in service today. They have no moving parts and require less care and attention than almost any other kind of electrical apparatus, but this is not a reason for neglecting them. General conditions under which they operate should determine the frequency of inspection and servicing. Any unusual symptoms, such as high temperature, off normal liquid levels, unusual noises, ruptured diaphragms, etc., are usually signs of trouble and should be investigated immediately. Power transformers can be divided into four different groups: oil-filled, askarel-filled, nitrogen-filled and dry type. Each type is designed for different applications and requires different techniques. The oil-filled transformer is probably the most widely used in industrial power systems today. Oil is used as the cooling medium. It also signals to the maintenance man the transformer condition. Hot oil in the presence of oxygen will deteriorate by oxidation. Copper and steel in the transformer act as catalysts in the reaction and the products are water, peroxides, acids and sludge. These products are harmful in that they mechanically weaken the insulation, cause corrosion, lower the di-electric strength of the oil, and impede cooling. A minute quantity of water lowers the di-electric strength to unsafe values, thereby making it necessary to treat the oil. One leading manufacturer has published a chart that shows that a fraction of a teaspoonful of water in a barrel of oil is enough to make it necessary to treat the oil. Many schemes and devices have been incorporated into design features of transformers to prevent contamination and deterioration but this is a design problem, not a maintenance problem.

The maintenance man takes over when the design features fail or do not function properly. Even though the chances of oil deterioration are small, it is necessary to check the oil at regular intervals and keep good records of the test results. Once oil deterioration has started, it is fast-moving and should be corrected as soon as possible.

There are approximately 18 to 20 tests for transformer oil which are helpful in determining its condition. Good results can be obtained in maintaining transformers by faithfully, at least once a year, taking a di-electric and neutralization value test of the oil. The results should be carefully recorded and compared with previous results. Any sudden changes are an indication that deterioration is beginning. It is then necessary to watch the oil and make more frequent tests. The di-electric strength

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There are many facets to the job of electrical maintenance . . . . repair costs can be very high on fully maintained equipment . . . . a thorough job of inspection, record keeping and servicing along with competent engineering will give long failure-free service.

test is a measure of the breakdown value of the oil between two flat 1-in. diam disk electrodes at 0.1-in. gap. The value should not go below 20,000 volts. If the value goes below this rating it is then necessary to pass the oil through a filter press to remove the moisture. The quickest method is to filter the oil into a separate clean container, then back into the transformer. This gives the total amount of oil two passes through the press which in most cases is enough to raise the di-electric strength to an acceptable value of at least 26 kv. If the transformer cannot be de-energized, the oil can be filtered by circulating it through the filter press and back into its own container. This is considerably slower since the unfiltered oil is being continuously mixed with the filtered oil. However, the method will prove satisfactory after a considerable length of time.

If, through a malfunction of the breathing device, a bad gasket, or for some other reason, large quantities of water have entered the oil, the filter press will not remove the water. Large quantities of water passed through a filter press will be very finely divided throughout the outgoing oil. The best solution under these conditions is to shutdown the equipment, drain the oil thoroughly, flush the tank and fill with new oil.

The neutralization number is a direct measurement of the organic acids by a titration process. New oil has a value of approximately 0.02. A value of 0.2 or higher indicates that sludging has begun and should be corrected. While suspended material and water can normally be removed by ordinary filtering processes, adsorbents are required to remove acids and soluble sludges. Good results can be obtained by circulating the oil through a type of fullers earth. This problem has been studied from an economic standpoint and it has been determined that below a neutralization number of 0.5, it is more economical to process the oil through an adsorbent than change it but above 0.5 the labor and material necessary to lower the neutrality to

an acceptable value is more than the cost of new oil installed in the transformer. There are, however, locations where the equipment cannot be removed from service and then it is necessary to salvage the oil by adsorbent methods regardless of the neutrality number.

Indoor transformers must be cooled and insulated by a nonflammable and nonexplosive liquid with the same electrical characteristics as oil. There are many such synthetic liquids available for transformers today. These liquids should be kept free of moisture, lint and dirt. Mineral oil is completely miscible with the synthetic liquids so it is very important to avoid contamination of the synthetic liquid with any type of oil. This would greatly lower the nonflammable and nonexplosive characteristics of the synthetic liquid. Most of the synthetic liquids have an irritating effect upon the skin and the maintenance man should carefully follow all of the manufacturer's safeguards before handling these materials. Most of the synthetic liquids also require special handling for dehydrating and purifying, and here also the manufacturer's instructions should be closely adhered to.

Nitrogen-filled transformers, when properly maintained, do not give any oil problems. Isolation of the oil by a blanket of nitrogen keeps moisture and oxygen away from the oil. The nitrogen is usually supplied from a cylinder placed on the side of the tank and the nitrogen is taken into the transformer direct from the cylinder when required. The only maintenance required is to check the gages at required intervals to make sure that the nitrogen pressure is maintained.

Air-cooled transformers require very little maintenance other than cleaning. The load and the amount of dirt in the cooling air determine the frequency of servicing necessary. Most locations can be maintained satisfactorily by periodically blowing out the dirt and wiping off the insulators.

Good maintenance procedures for circuit breakers are imperative. If a circuit breaker fails to operate, the potential hazards to other equipment on the system can be very serious. Numerous factors affect the planning of a schedule for maintaining a breaker. These factors vary on different systems and at different locations and should be studied individually. Considered should be the cleanliness of the area in which the breaker is located, the vintage of the breaker, fault conditions under which it may have operated, and number of operations. Regardless of the number of operations it is good practice to service any kind of breaker at least once a year. If a breaker is not serviced at least once a year, there is a great risk that it may fail to operate when called upon to do so. This is especially true of breakers that do not operate from one year to another. On these breakers lubrication dries up, bearings freeze, and it is sometimes even impossible to trip them manually. Detailed maintenance instructions are always furnished by the manufacturer and these should be carefully reviewed by the maintenance personnel. A step-by-step procedure should be set up for each individual type and manufacture of breaker. A typical procedure to be followed for an air circuit breaker is as follows:

1. Inspect breaker operating or solenoid mechanism for the following: loose hardware, loose cotter pins, loose locknuts, roller surfaces for wear, correct linkages, good electrical connections, proper lubrication and correct adjustments.
2. Inspect movable and stationary contacts.
3. Clean all insulating parts.
4. Clean arc chutes and check for damage.
5. Clean and lubricate disconnecting devices.
6. Inspect all electrical control circuits for worn parts, loose connections, freedom of operation, etc.
7. Operate breaker slowly with maintenance closing device to check all clearances and proper contact.
8. Operate breaker electrically to check electrical operation.

A typical procedure for an oil circuit breaker is as follows:

1. Untank breaker and check contacts.
2. Inspect insulating parts.
3. Wipe all parts clean of carbon.
4. Inspect entire breaker for missing cotter pins, loose locknuts, loose hardware, correct adjustment, etc.
5. Lubricate operating mechanism.
6. Test di-electric strength of oil.
7. Check all gaskets, gages and valves to prevent leakage.
8. Operate breaker with maintenance closing device to check all clearances and proper contact.
9. Reassemble tanks and check electrical operation.

As can be seen from these procedures for breakers, it takes a meticulous man to properly service a breaker. There are many little details that have to be checked and and checked thoroughly. A breaker is not better than the weakest cotter pin, or loose locknut or frozen trip bar. The maintenance supervisor should, therefore, be very careful in selecting the right type of person for this job. If all these factors are thoroughly followed circuit breakers will perform their function on a power system without failure.

Rotating equipment requires more frequent inspection and maintenance than static pieces of electrical power equipment. Typical pieces of rotating equipment found on a power system include turbine generators, motor-generator sets, rotary converters, flywheel sets, etc. To maintain rotating equipment the electrical man must also have a good mechanical background because many of the problems are of a mechanical nature. A good step-by-step procedure for rotating equipment by the inspection and maintenance personnel, however, that is strictly adhered to, will, as in the case of other equipment, eliminate most failures. Proper lubrication is of paramount importance to rotating equipment and is, therefore, the first duty of an inspector when checking a rotating machine. The oil supply, condition of the oil and temperature of the bearings should be checked. If the oil supply is kept at required levels and kept clean, the bearings will present no problems for many years of operation. However, if lubrication is carelessly handled, bearings can fail and cause many mechanical problems as well as cause damage to the insulation from oil leakage. Bearings can furnish clues to other problems also.

Bearings will become hot from end thrust due to improper leveling or magnetic pull. These problems must be solved at their source to prevent excessive bearing wear. Another source of bearing trouble is not a me-

chanical problem but an electrical problem. This is the pitting of the bearing and shaft from bearing currents. This is very simply solved by placing insulation under the pedestals, but maintenance personnel must be careful not to short circuit the insulation through piping, painting over the insulation, etc.

The second step that an inspector should take when inspecting rotating equipment is to check for unusual noises. Any unusual noise should be checked out immediately and the source determined. This can be quite a problem but usually the process of elimination can break the problem down to a solution. Causes of noises can be from loose hardware, mechanical or electrical unbalance, shorted coils, foreign material in the windings, system unbalance, dirt, etc.

Commutation on d-c rotating machines is considered by many maintenance people to be the most intricate problem they have. There are so many factors involved that very seldom is the right brush originally put on a machine. It then falls to the maintenance personnel to solve this intricate problem. How brush problems are solved is too lengthy to go into in the scope of this paper, but it is a real source of pride and accomplishment for maintenance personnel when the so-called "chocolate brown" textbook-colored commutator is attained. After the solution of the brush problem and good commutation is attained, there are many maintenance practices that can keep the commutator in good condition. One of the oldest, but still the best, cheapest and easiest ways to maintain a satisfactory commutator, is to polish it with a piece of clean canvas. Canvas removes oil, grease and undesirable deposits from the surface of the commutator without destroying the surface film. It also smooths and burnishes the commutator. To be effective the canvas must be applied often.

When the d-c rotating machine is inspected, the commutator and commutation should be closely observed so that faults can be detected early and corrected. Most commutation faults increase at a very fast rate and if not corrected immediately, may result in a costly shutdown and repair job. As can be seen from these few illustrations, rotating machinery can be a constant source of trouble but, as in the case of other equipment, a well scheduled, thorough inspection and maintenance program can make a rotating machine as easy to maintain as other equipment.

In the last decade mercury arc rectifiers have come into wide use as the chief source for direct current on industrial power systems. They were supposed to be a maintenance man's dream in that they eliminated all the troublesome problems of motor-generator sets and rotary converters. This they did do, but they are, of course, not maintenance free. All of the auxiliary equipment such as vacuum pumps in pumped rectifiers, heat exchangers, water pump and firing circuits, as well as the main rectifier itself, must be maintained. These problems have somewhat changed the requirements for maintenance personnel. A man who is capable of changing brushes on a motor-generator set is not necessarily capable of maintaining a firing circuit on a double wye connected rectifier or of changing a faulty ignitor rod. Rectifiers have proved, however, that they do require less maintenance than older conventional means and are a good reliable source of direct current.

A preventive maintenance program on electrical power equipment is no better than the condition of the transmission system feeding or tying this equipment together. On an industrial power system, transmission systems vary from high voltage, through medium voltages, to low voltages, both a-c and d-c, both above and below ground. The chief problem on systems above ground is keeping the hardware in good operating condition. This includes strain clamps, eye bolts, insulators of all kinds, lightning arrestors and many other items. An inspection program is not very helpful in line maintenance because not much can normally be told by observing lines anywhere from 25 to 125 ft above ground. It is, therefore, necessary to carefully follow a planned servicing schedule. The frequency of this schedule varies widely from one circuit to another with load, dirt conditions, age of circuit, type of insulators and many other variables included in determining the service schedule. At the servicing time, all the insulators should be cleaned and the hardware carefully checked and, if necessary, changed. Cleaning of insulators can be accomplished in numerous ways with numerous products. This again depends on location and type of insulators, and should be checked from an economic standpoint. The cheapest and best method should be used. Sometimes it is not practical to de-energize the line for cleaning and then "hot-stick" method should be applied. There are many units on the market today for hot cleaning and most do a thorough job, but extreme care must be exercised to insure that the job is done safely.

Underground systems have very different problems from overhead systems in that there is normally very little hardware to maintain. The problem is one of periodically testing the insulation of the cables and watching for any marked changes. Records must be systematically kept so as to be able to compare results with previous tests. If these methods are carefully followed, transmission systems rarely fail from maintenance problems.

Maintenance of relays has been saved for last in this paper because relays are the last item that a maintenance man can rely on to mitigate the damage from a failure caused from either a poor maintenance condition or from uncontrollable factors. Normally, power systems are thought of in their more impressive parts—big turbines, transmission lines, transformers, motor-generator sets, etc. Relays are just as important because they protect these large expensive items. It is one of the duties of maintenance personnel to insure that relays will operate and operate properly when called upon to do so. A perfectly engineered relay scheme is absolutely useless if the relays fail to operate because of poor maintenance practices. Unlike other items on a power system, relays are idle most of the time. This lack of operation must be compensated for in some way to be sure that the relay will operate when necessary. This is accomplished by a thorough relay testing program. A minimum test and maintenance technique should be outlined for each type of relay and these tests should be carefully recorded and compared with previous results. This way any changes or deterioration in the relay can very easily be picked off.

The final test of each relay installation should be to actually close the trip contacts on the relay and trip the associated circuit breaker. This definitely guarantees the condition of the trip circuit. Relay maintenance

personnel must be thoroughly educated in the purpose and operation of relays because if a person is not thoroughly acquainted with relay procedures he can do more harm than good. A good relay maintenance scheme, that is properly followed, can be very helpful to maintenance personnel by preventing or limiting the damage to the equipment that they protect.

As can be seen from these general considerations and specific problems previously outlined, maintenance of electric power equipment is a many faceted job. It is also a responsible job in that repair costs can be extremely high on poorly maintained equipment and also the cost of operating delays from poorly maintained equipment can be astronomical. The recognition maintenance men receive largely depends on the results of the maintenance program. If a thorough job of inspection, record keeping and necessary servicing is done without exceptions by expert personnel, coupled with competent engineering to adapt equipment to specific problems, any type of electric power equipment will give the long failure-free type of service for which it was designed.

Discussion

PRESENTED BY

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J. D. O'Roark: Important as large expensive electrical equipment is, the safety to life and limb of electrical maintenance personnel is even more important and may we add emphasis to the need of practical and effective safety rules and regulations designed to adequately protect the worker in line with prevailing conditions. This requires a program of thorough diagnosis, planning, instruction, understanding and above all enforcement.

Since oftentimes other maintenance groups such as painters, riggers, pipefitters and other construction personnel are often required to work in proximity of high voltage circuits, power maintenance personnel have the additional responsibility to insure the safety of others.

The provision of up-to-date power system prints, adequate hot test sticks, grounding chains, rubber blankets, shoes, armlets, gloves, etc., properly stored and periodically tested, in each of the major substations is part of such a safety program. The storage of rubber goods after testing, in sealed plastic envelopes has been found to add greatly to the safe life of same.

The value of complete and accurate records of inspection, repair and spares for major electrical power equipment cannot be overemphasized.

The ready availability of pertinent data ofttimes contributes substantially toward expediting repairs in case of breakdown. Such records are of additional value in processing insurance claims.

In regards to cleanliness of electrical power equipment, the author has again covered a large subject effectively in a few words. Few industrial plants present the variety of dirt control problems found in an integrated steel plant. Our observation is that Engineering Departments frequently do not give thorough and adequate recognition of dirt problems attendant to a new plant facility. Even after the conditions are obvious and defined, corrective measures are seldom forthcoming because "the appropriation is closed," consequently maintenance personnel are saddled with a dirt and cleaning problem that adds extra maintenance expense.

Since most steel plants of any size have a wide variety of makes, ages, styles, ratings and applications of circuit breakers, each with its own electrical and mechanical design and characteristics, it is evident that here is one place where experienced service personnel are an absolute must. Prompt contact with the breaker manufacturer should be made for any repetitive faults.

In commenting on maintenance of rectifiers, in addition to the items covered by the author, we have experienced trouble in the cooling systems due to water contaminants, failure of capacitors in control circuits, adjustment of ignitors, etc. Since the design of rectifier parts and accessories leaves little chance to improvise in case of failure, the rectifier and associated equipment, upon installation, should be studied for spare coverage. These spares should be carded, tagged for identification and stored in a cabinet located in the rectifier area.

Passing along to the matter of power system relays, we must realize that these comparatively small and inexpensive devices are the first line protection for large units costing thousands of dollars. With the variety of relays now available a high degree of protection can be had, limiting any fault to comparatively small damage *provided* the relays function. No one can emphasize too strongly the necessity and value of adequate relay maintenance and testing. Quoting for emphasis from the author's paper, "A perfectly engineered relay scheme is absolutely useless if the relays fail to operate because of poor maintenance practice."

It is our practice at Weirton Steel that any time a fault occurs on the power system, an accurate and on the site record is made of any and all relays which operated, then an over-all study and review to ascertain:

1. Did all relays operate which should have?
2. Did any relay operate which should not have?
3. Then after the pattern is decided, make any necessary corrections in relay settings, etc.

It is further suggested that in line with any major additions in power generating equipment or added capacity in purchased power tie-in, that a power system short circuit study be made on one of the several available boards to determine maximum short circuit kva at various points on the system and the adequacy of rupturing kva rating of the various breakers determined.

In way of general comment, the author's paper reflects the gradually increasing level of ability and skill of the maintenance employee required for servicing the several very critical and exacting areas of a large power system. In few other areas will capable and experienced personnel pay larger dividends.

Harold Miller: The first paragraph in the body of the author's paper is devoted to the safety of personnel. He lists four steps to safety:

1. The job is analyzed for safety.
2. Safe procedures are written.
3. Personnel are trained to follow the procedure.
4. Safety rules are enforced.

By placing safety first and having an organized method of communication this hazardous work can be done safely.

In the author's material on preventive maintenance he lists as the No. 1 item: A systematic periodic and competent inspection. He states that a certain type person is required for the inspection job. We agree. He must be thorough. He must be persistent. He must have the ability to see and recognize signs of a future equipment failure, even after a dozen inspections.

To practice preventive maintenance, the author emphasizes the importance of keeping records:

A good record of equipment inventory and performance is necessary.

A good record should consist of the name plate data of the machine. The record should contain the lubrication cycle and the type of lubricant.

It should record the inspection report and inspection cycle.

It should list the critical spares.

It should contain the replacement parts used.

It should include a record of the major maintenance cost on the equipment.

The record system must also flag the inspection and lubrication cycles for the supervisor.

The author discusses maintenance of transformers, circuit breakers, rotating equipment, rectifiers, transmission lines and relays. He outlines preventive maintenance procedures for this equipment. It is very good.

In the paragraph on rotating equipment he lists the problem of bearing and shaft pitting. We have had this condition occur on a motor generator set. This is a difficult condition to locate before damage has occurred. We do not know any reliable way to test the pedestal insulator without lifting the shaft clear of the bearing.

The other method we have tried is to connect a wire to the pedestal and touch the other end to the bed plate. If a spark occurs the insulation is good, if there is no spark the insulation may not be good. The method is not very reliable.

Starting a preventive maintenance program in a steel plant is a gigantic undertaking. It takes much work and patience. The results come slowly. Doubts of its value may arise.

We have set up a preventive maintenance program for our 2300-volt, 6900-volt and 25,000-volt equipment.

Our program is set up for the following reasons:

1. To protect the capital investment of the company.
2. Insure quality service to the various production departments.
3. Minimize operating and maintenance cost.

Our schedule of repairs is to be established by:

1. Study of past performances.
2. Manufacturer's recommendations.
3. Studies of inspection records.
4. Recommendations of repairmen on the job.

John H. Greiner: *Transformer*—As a means of making rapid and simple field tests of insulating oil it is suggested that the spot test be used. This test was developed by our company and is an accepted ASTM standard test. Estimations of acidity and interfacial tension can readily be made. The condition of the oil and whether or not complete laboratory analysis is required can easily and quickly be determined.

The author discusses maintenance of power transformers but does not specifically discuss load tap changing equipment which is present in certain instances. It is desirable to establish an inspection program on this portion of the equipment and some of the suggestions outlined for circuit breaker inspection would apply here. It is important to remember that the load tap changing part of the unit will probably require more frequent inspection than the transformer portion of the unit.

Switchgear—As a manufacturer, it has been our objective to provide equipment that allows inspection and maintenance to be easily performed, resulting in a minimum of time required to carry out such work. This is especially true in the case of circuit breakers. Within recent years, their size has increased due to the higher interrupting ratings, thus bringing about larger components which must be handled. The requirement for simplified maintenance has introduced such design features as hydraulic tank lowering and raising for oil circuit breakers, and smaller and lighter weight components in the air circuit breakers.

For nearly 50 years, the mechanical induction type protective relay has been the sensing means of abnormal system conditions. As with all mechanical apparatus, relay maintenance is highly important to assure the proper operation, since an inoperative relay might cause extensive repairs to be made to major pieces of electrical equipment as has been discussed.

Our recently introduced line of relays, relying completely on static components is, in our belief, a major breakthrough in the attempt to drastically reduce or preferably eliminate the maintenance presently required for present-day devices. Likewise, use of static components will result in providing more desirable relay characteristics when over-all system co-ordination is a prime consideration.

Rotating equipment—The emphasis on periodic readings of insulation resistance and recording thereof, cannot be over done on any type of rotating machine, and especially on d-c machines where creepage distances are necessarily short and carbon dust is always present. We believe that such data should be taken monthly for machines of 100 hp and larger.

Commutator and brush maintenance is of the greatest importance not only with respect to the usual replacement of worn brushes and keeping the commutator surface true and clean, but also to maintain brush tension to 2½ to 3½ psi and to keep the mica undercutting clean.

We frequently find that some older d-c machines which have severe overloads or difficult commutating conditions could be improved by using a more modern brush grade or brush structure than originally furnished. This is also true for commutators which have a tendency to streak or thread due to a low value of average brush contact density. ▲

X-Ray Gages Increase Output On Fast Foil Mills

TO keep up with growing production needs for aluminum sheet and foil, Mirro Aluminum Co. has turned to x-ray gages for rapid automatic thickness measurement and control.

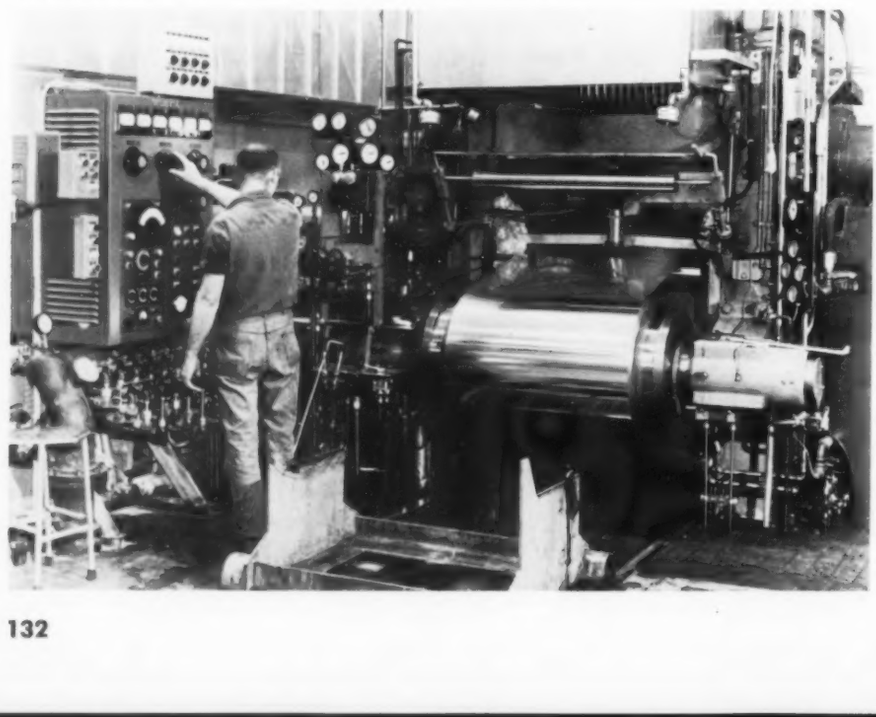
Gages, manufactured by Weston Instruments Div. of Daystrom, Inc., have been installed on two mills in the new Wisconsin plant. One gage permits automatic operation of a 48-in. hydraulically adjusted foil mill at speeds up to 2000 fpm. Another gage—installed on a heavy duty, 60-in. cold mill—not only maintains tolerance of sheets through regulation of screw-down rolls but automatically compensates for shifts from one aluminum alloy to another.

Mirro's fabricating and packaging operations use about 40,000,000 lb of aluminum sheet per year. Since a manufacturing variation of 0.0001 in. on the average gage rolled could result in excess usage of 160,000 lb of metal per year, it is understandable why Mirro is conscious of the value of accurate gage control.

Previously, Mirro cast and rolled 100-lb slabs and coils of metal on relatively slow equipment, and all handling was done manually. In the new mill, the company is casting slabs weighing up to 6000 lb and rolling coils of up to 3000 lb. The rolling is being done on new, larger and faster equipment.

With the gages, Mirro expects three major advantages: (1) higher recovery of sheet within tolerance, (2) fewer press department complaints over off-gage material which might give trouble when press-formed, and (3) lower metal cost per square foot of sheet.

Figure 1 — An adjustment is made for foil mill speed. Control panel also houses console equipment for gage which measures and controls sheet thickness automatically once operating speed is attained. Gaging instrument is noncontacting, employs x-rays which impart no residual radiation.



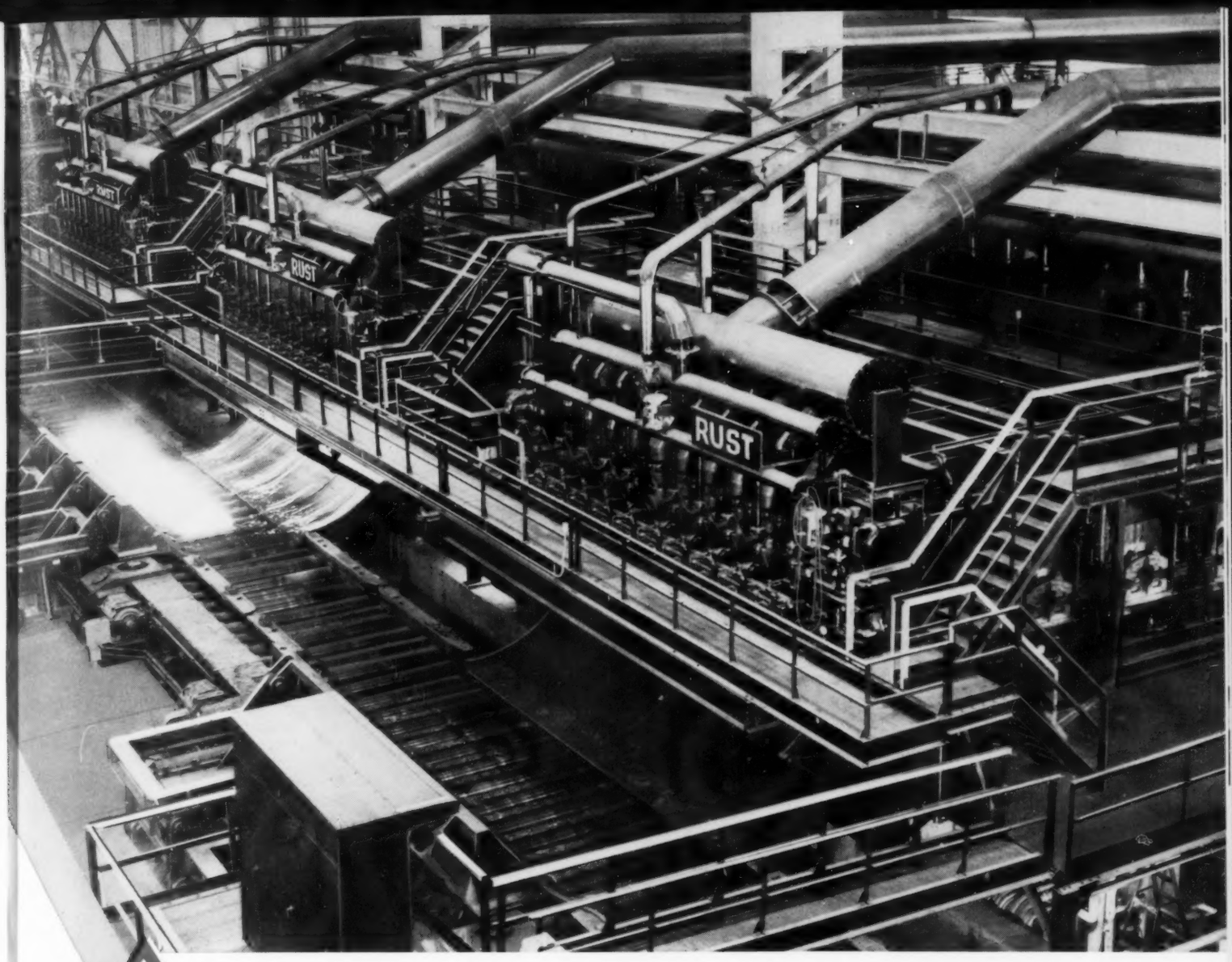
FOIL MILL

Precision is a keynote. To keep the foil equipment free of dust which might contaminate the metal or cause pinholes to appear, the entire mill is enclosed in an air-filtered, pressurized room.

Mirro's foil mill is able to handle coils up to 48 in. wide and will roll thicknesses ranging from 0.0007 to 0.025 in. Average length of a coil of household foil (36½ in. wide and 0.0007 in. thick) is about 15½ miles and the mill will hold tolerances over the entire length within plus or minus four per cent.

On the rolling line an energy source transmits a pencil-thin beam of x-rays from below the aluminum sheet toward a service unit above the sheet. Thickness of the moving aluminum is measured by changes in the intensity of radiation transmitted to the pickup unit. This unit, in turn, signals electronic elements in the console cabinet which convert the radiation variations into terms of percentage of variation from nominal thickness.

The foil mill operators need only to keep a watch on the console-mounted dial to note the smallest deviation from the zero-centered reference point. A red warning light flashes on when the set deviation is exceeded. Gage accuracy is within



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Slab Reheating Furnaces

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THREE completely AUTOMATIC gas-fired RUST FURNACES, designed and constructed for Kaiser Steel Corporation's Fontana Works. Each furnace is designed to heat cold slabs to rolling temperatures at a rate of 150 tons per hour. Internal dimensions of furnaces: 24′ wide x 100′ long. Metallic recuperators minimize fuel consumption. This zone-fired type of Rust furnace is used by virtually all strip mills throughout the world. Consult us about your furnace requirements – melting, reheating or heat treating.

THE WHOLE JOB IS ONE JOB WITH A "RUST PACKAGE CONTRACT"

One contract covers everything from original idea through furnace start-up. One responsibility for design, manufacture, erection and initial operation. One overhead and profit (with substantial savings to you) on all phases of the work, including wiring and piping.

RUST FURNACE COMPANY

930 Fort Duquesne Boulevard, Pittsburgh 22, Pa.

Pioneers in Furnace Design

plus or minus two per cent in the range of 0.0007 to 0.002 in. and within plus or minus one per cent in the 0.002 to 0.025-in. range.

A two-man crew operates the foil mill, starting the metal into the rolls and removing it from the rewind at the end of the mill. After being set for desired thickness, the gage automatically compensates for deviations by speeding up or slowing down the mill or by increasing or decreasing pressure on the rolls.

Without automatic gaging, thickness measurements on aluminum foil are usually made from edge-cut samples taken "on the fly" and checked with a micrometer. The noncontacting x-ray gage takes continuous readings, regulates the mill and automatically shuts down all equipment if there is a break in the sheet or when a coil is completed. Differences in foil speed have no effect on gage accuracy and correction signals are instantaneous whether the foil is making its first pass at the average 800 fpm, the intermediate pass at 1500 fpm or the final run at 2000 fpm.

Mirro's fast rolling entirely eliminated the possibility of using the old gaging method. Heating of the rolls is a factor in causing sheet variations even with a slow foil mill but at Mirro it is a major problem which can be solved only with automatic, continual adjustment of the rolls.

COLD MILL

Operation of the gage-equipped cold mill began in March, 1960. A pair of work rolls—15 in. in diameter and 60-in. wide—reduce the metal stock by 50 per cent on each pass. By automatically adjusting roll screwdown, the x-ray gage will constantly maintain nominal thickness within a narrow bend of tolerance. Built-in compensators maintain accuracy even with various alloys. Gage operation on the sheets, which range in thickness from 0.125 to 0.010 in., is virtually identical with that of the foil mill. ▲

FERROUS DEVELOPMENTS In The Dnieper Area of USSR

by A. SANIN

THE Dnieper area's Ukraine iron and steel industry is undergoing rapid development. In the three-quarters century of its existence this branch of industry has never grown as at great a rate as today's.

The blast furnaces in this area have recently been using natural gas. This practice was introduced by the staff of the Petrovsky plant jointly with the scientists of the Iron and Steel Institute of the Ukrainian Academy of Sciences and the Dniepropetrovsk Metallurgical Institute.

Three years ago a trunk pipeline was laid from the Shebelinsk gas deposits to Dniepropetrovsk to serve the city's power stations, open-hearth furnaces and the rolling mills' ovens with this fuel. This gave the Dniepropetrovsk iron and steelmakers the idea that natural gas could be employed in blast-furnace operations as well. After slight reconstruction at blast furnace No. 4 at the Petrovsky plant, it was supplied with natural gas. The furnace personnel mastered the new technology which gave positive results, the output of the furnace increased, the input of coke was reduced and production costs were lowered. Soon a second and then a third blast furnace were modified to operate on gas fuel.

The blast-furnace men at the Dzerzhinsky plant made use of the experience gained at the Dniepropetrovsk plant, and put their blast furnace No. 12 to work on the new type of fuel.

Parallel with the in-feed of natural gas, the operators supplied oxygen-enriched blast to the furnace. About four per cent increase of oxygen proved to be sufficient to raise the output of the blast-furnace process. The plant is able to handle more ore and uses less limestone and coke. The iron yield per ton of flux and fuel increases, and the efficiency of the furnace is raised.

A short time later natural gas was introduced not only at the blast furnaces of Dniepropetrovsk and Dnieprodzerzhinsk, but also at those in Krivoi Rog, Zaporozhye and the Donbas.

Immense natural gas resources have been discovered in the depths of Soviet Central Asia and are now being developed there, and Uzbekistan's iron and steel operators now have the opportunity of making wide use of this cheap fuel for boosting output.

At the same Petrovsky plant, on September 21, 1956 the converter plant made its first melt of steel on oxygen blast.

Converter steel production is developing daily in Russia. Bessemer plants are being reconstructed, newer and better converters with oxygen blowing are being built and commissioned at new enterprises, a powerful converter plant at the Lenin Iron and Steel Works in Krivoi Rog has been putting out steel for two years already. This method is being introduced in the plants of the Donbas and other industrial regions of the country. An interesting technique is the reducing of the melt temperature somewhat by injecting water into the converter simultaneously with the oxygen. ▲

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Sizes in inches
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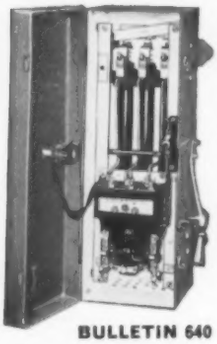
AUTOMATIC AUTOTRANSFORMER starter for squirrel cage motors that should not be started at full voltage. The autotransformer reduces line voltage during acceleration. Taps permit adjustment of voltage applied to the motor.

BULLETIN 748



MANUAL STEPLESS RESISTANCE starter has graphite compression disc resistors for velvet smooth starting of squirrel cage motors. Starting of the motor is under the complete control of the operator.

BULLETIN 640

AUTOMATIC RESISTANCE starter has graphite resistors automatically inserted in series with the squirrel cage motor at starting. Resistors can easily be adjusted to motor and load conditions, giving velvet smooth acceleration.

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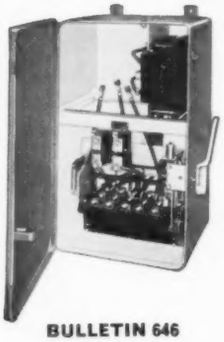
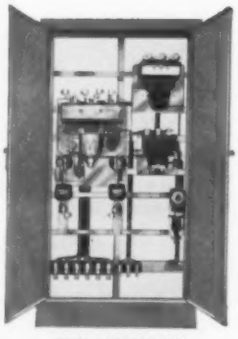


MANUAL AUTOTRANSFORMER starter for use where load conditions or power company rules require reduced voltage starting. The air break starter shown has double break, silver alloy contacts.

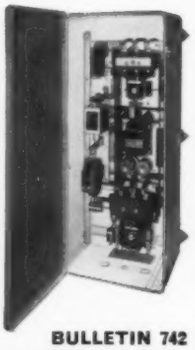
BULLETIN 646

AUTOMATIC MULTIPOINT RESISTANCE starter for use on network systems. Resistors inserted at starting are cut out in definite steps. Time intervals adjustable to provide velvet smooth starting.



BULLETIN 741

AUTOMATIC STEPLESS RESISTANCE starter is not equalled for velvet smooth motor acceleration. It will satisfy any power company requirement. Eliminates lamp flicker on networks used for power and lighting.



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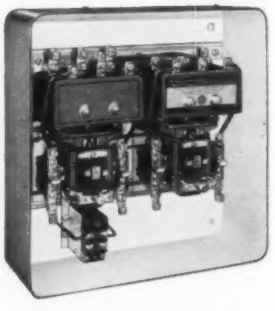
AUTOMATIC PART WINDING starter for use with squirrel cage motors having two separate parallel windings. Made in two-step type, and three-step type with resistance connected in the line on the first step.



BULLETIN 736

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QUALITY MOTOR CONTROL

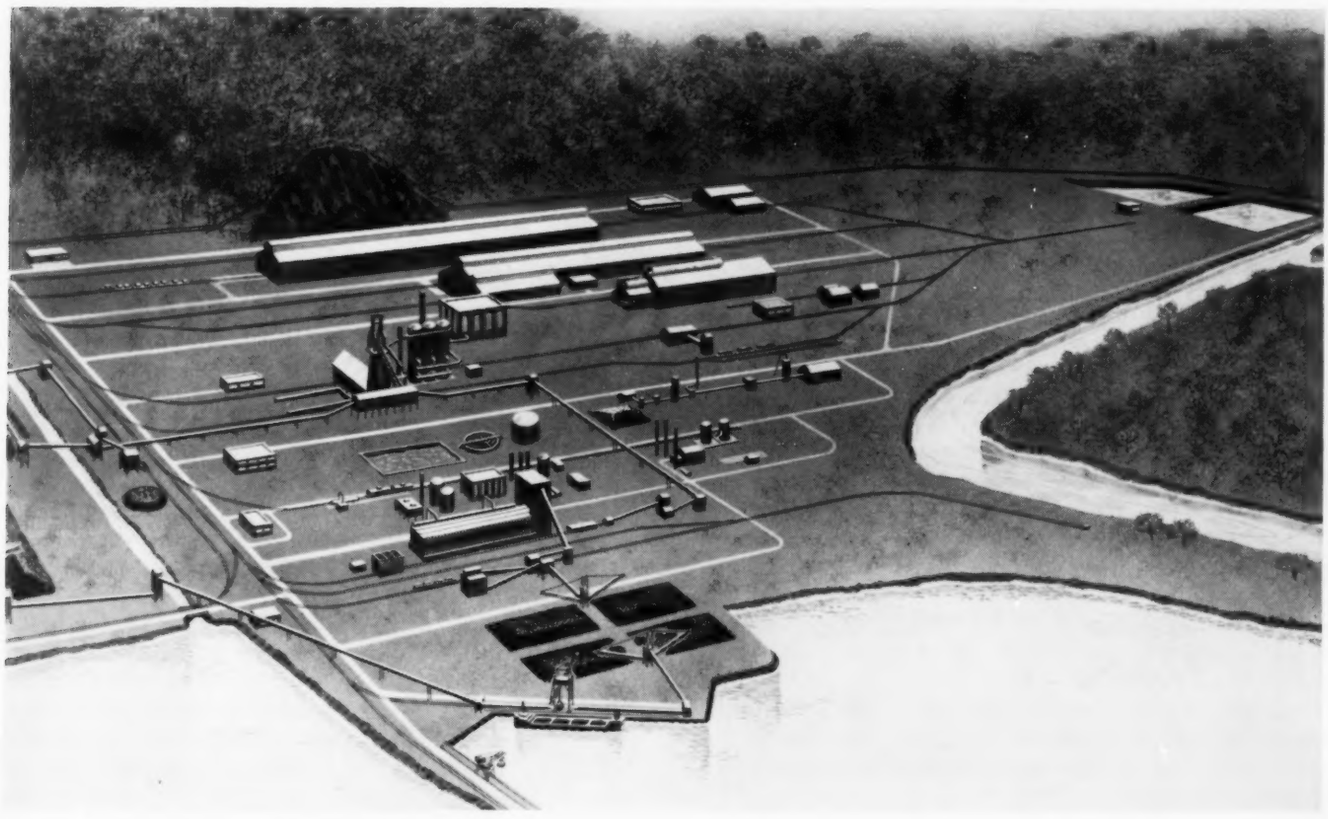
Financing Set For New Turkish Steel Plant

THE Development Loan Fund has announced it will sign a $129,600,000 loan agreement covering approximately one half of the financing of an integrated steel plant to be built at Eregli, on Turkey's Black Sea coast. This will be the single largest U. S. Government loan ever made for an industrial project overseas.

The plant will be owned by a private corporation (Eregli Iron & Steel Works) already established in Turkey and will cost an estimated $245,000,000, including interest and working capital. Equity financing amounting to around $59,000,000 will combine the interests of U. S. and Turkish private investors and the Turkish Government. Control of the company will be vested in its private investors. Shares owned by the Turkish Government will be made available for sale to Turkish citizens at any time on the basis of an agreed pricing formula. U. S. firms participating in the equity financing will be Koppers Co., Inc., Blaw-Knox Co. and Westinghouse Electric Corp.

Additional loan financing, amounting to about $25,000,000, of the foreign exchange cost of this

Figure 1 — Integrated steel plant of Eregli Iron and Steel Works, on Turkey's Black Sea coast. Ships unload coal and iron ore at the dock facilities (near foreground). The coke oven battery is shown in the center foreground; and behind that is the blast furnace. To the right and to the rear of the blast furnace is the basic oxygen furnace shop. Toward the rear of the sketch are the primary rolling mill, and then (farthest from view) the cold rolling and tinplate finishing mill.



project will be provided from European sources and the Chase International Investment Corp. of New York. A loan of around $21,000,000 for Turkish lira costs will be provided by the Turkish Government.

The mill will produce and sell flat steel products in Turkey at costs and prices no higher than the cost of comparable imported products. The principal raw materials, coal, iron ore, dolomite and limestone, are available in Turkey. The plant itself will be situated within a short distance from Zonguldak, the principal metallurgical-coal producing area in Turkey, and within a reasonable distance of Turkey's principal markets.

The need for steel in Turkey far outstrips that country's present steelmaking resources. Purchases of steel from other countries have been severely restricted because of shortages of foreign exchange, and constitute no indication of the actual need. The one integrated steel mill now operating in Turkey produces principally basic steel products such as structural sections, bars and rails. There is little or no production of, and a great need for, flat rolled steel products of the type to be manufactured at the new Eregli mill.

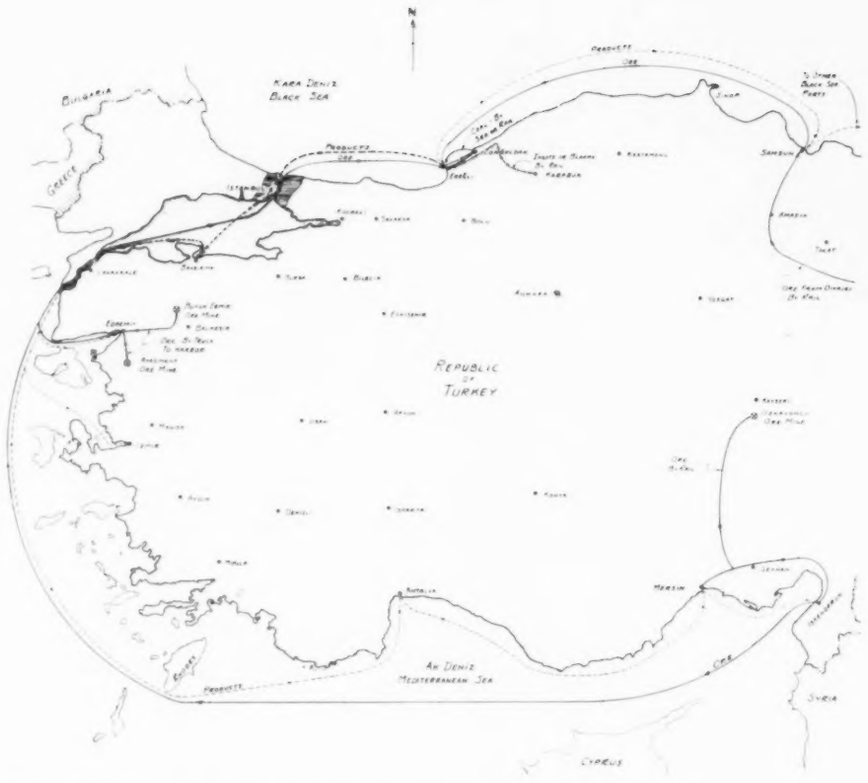


Figure 2 — Sketch shows material assembly and product distribution.

THE PLANT

Eregli is located about 20 miles west of Zonguldak, Turkey's principal coal-producing area, and 220 miles east of Istanbul. This site for the plant was selected after five alternative sites had been considered.

The plant will consist of a by-product coke plant, a blast-furnace plant, a basic oxygen-furnace plant, a rolling-mill plant, and a power and steam plant. Materials-handling facilities, consisting of a dock capable of accommodating two 10,000-ton ships on each side, plus railroad tracks, conveyor belts, cranes, crushing and screening plants, stackers and mixers, and loading and hauling equipment also will be required.

Initially the plant will have an annual output estimated at 520,000 net tons of ingot, but it is designed for ultimate expansion to more than a million tons. The initial output is expected to include 120,000 tons of steel ingots for sale to the existing steel mill at Karabuk; 60,000 tons of plates, 85,000 tons of cold rolled sheets, 31,000 tons of hot rolled sheets, 55,000 tons of tinplate, 9000 tons of strip and 55,000 tons of skelp. Its finishing capacity will initially be in excess of the plant's ingot production. It is estimated that the plant will be able to operate at a breakeven point of around 60 per cent of its initial capacity.

The major raw materials—coal, iron ore and limestone—are all available in Turkey. The plant will produce about two-thirds of its own power, with the remainder coming from an adjacent power grid. Water is available at the plant site. Employment will be provided for 3000 to 4000 people. Semi-skilled and unskilled labor is available in the region, and key personnel will be obtained from the Karabuk Steel Works, Koppers Associates or from other sources.

Apart from the mill itself, certain off-site facilities will be provided under separate financing arrangements. These will include railway and road connections between the port of Eregli and the plant site; a pier addition to Eregli port; port facilities for ore shipments; coal and ore boats; mine development at one or more of various iron-ore properties; and housing for plant employees.

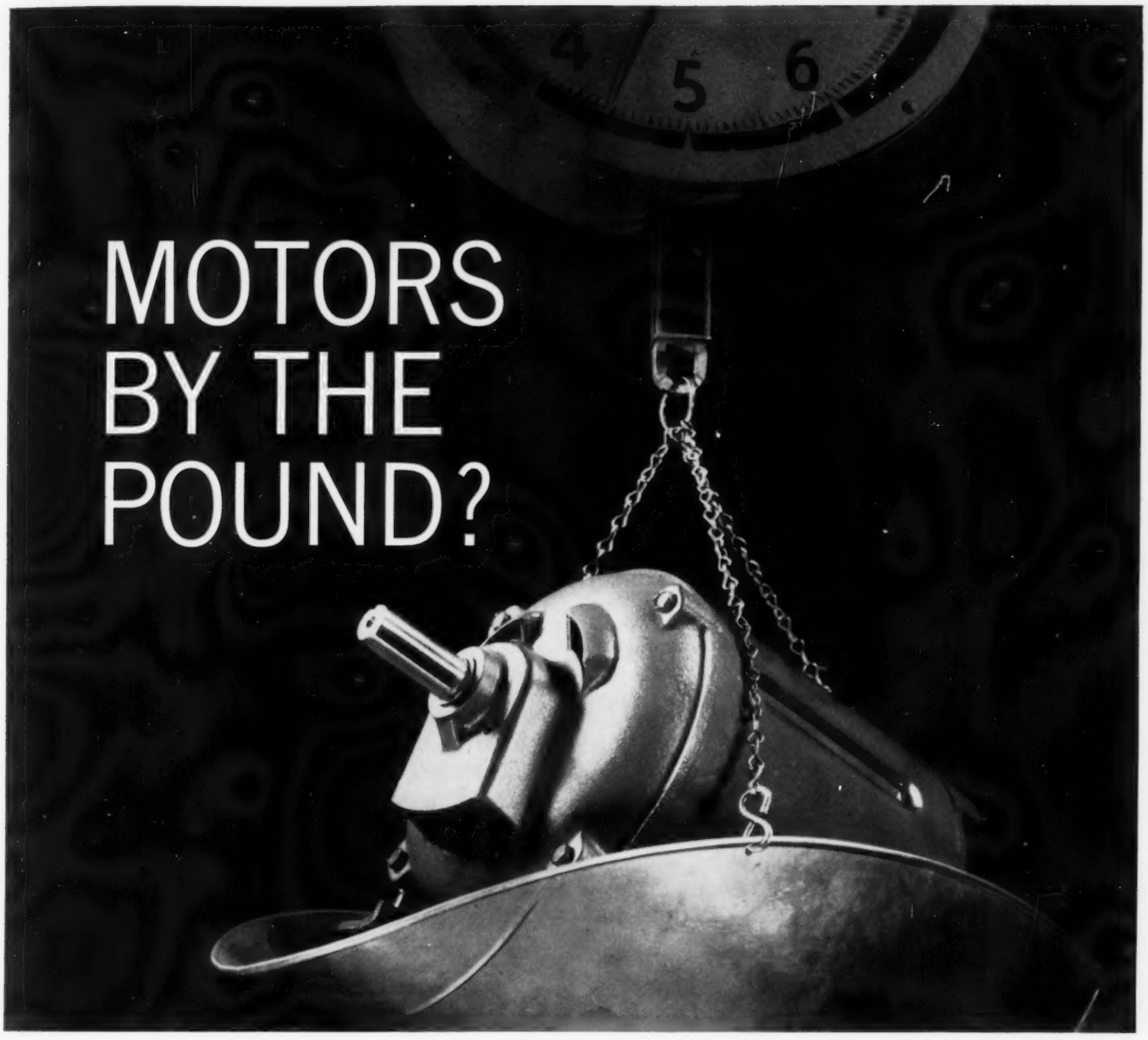
PLANT CONSTRUCTION

U. S. firms participating in the equity are acting as a joint venture and will be responsible for the design and general engineering, will assist in and coordinate the procurement of material, and the supervision of construction of the plant, and will provide management services under contract.

Koppers Co. Inc., will furnish all material, equipment, and supplies for the materials-handling facilities, the coke plant, the blast-furnace plant, and the oxygen-furnace plant; will perform engineering services including site planning, construction supervision, and the integration of all phases of the work; and will perform management services connected with the operations of the plant.

Westinghouse Electric International Corp. will furnish materials, equipment, and supplies for the powerplant and substations, the rolling-mill electric installations, and distribution equipment.

Blaw-Knox Co. will provide equipment, services, and supplies in connection with the rolling mills. Turkish contractors will participate in the civil construction of the plant under the supervision of Koppers Co., Inc. ▲



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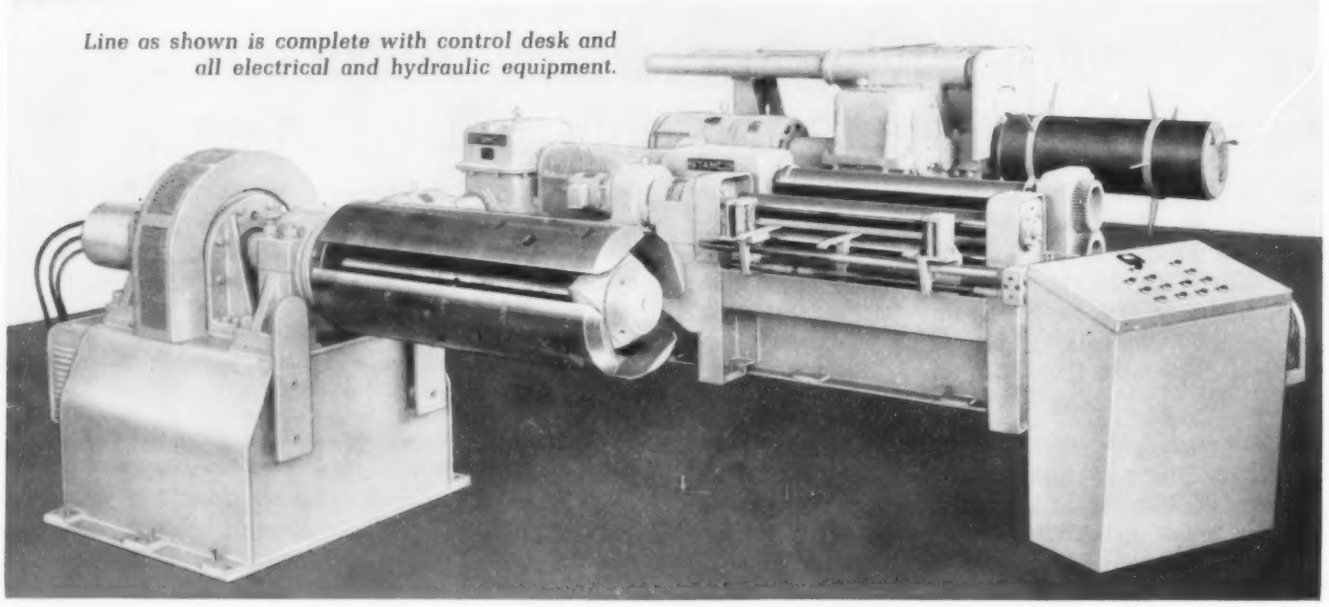
Line as shown is complete with control desk and all electrical and hydraulic equipment.



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Immersion Ultrasonic Inspection Used To Check Steel Plant Products

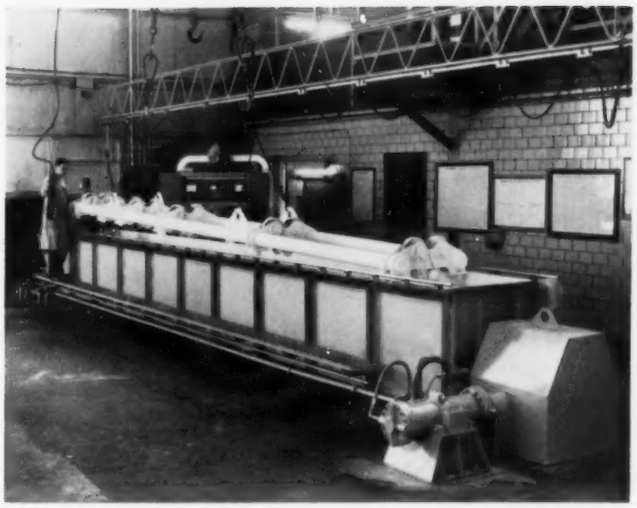


Figure 1 — View of the turning unit shows the ease of removal, position of rolls and the air cylinder that operates the square turner.

IMMERSION ultrasonic inspection has replaced most contact methods of testing at The Timken Roller Bearing Co.'s Steel & Tube Div. in Canton, Ohio. The company's ultrasonic unit provides faster production, reduced costs, improved uniformity and added reliability in the inspection of forging squares, round bars and large seamless steel tubing.

The ultrasonic technique's use has been largely confined to final inspection of aircraft and missile components which presently consume the bulk of ultrasonic quality steel. A significant proportion of the steel produced for these demanding applications is processed in long, symmetrical shapes of moderately large sections which can be tested more efficiently by using the immersion technique.

The immersion and contact methods of testing differ fundamentally in the manner in which the ultrasound beam is transmitted from the search unit into the piece to be tested. In immersion testing a water column of up to a few inches separates the search unit from the test surface, as contrasted with the contact method in which the search unit is in intimate contact through a very thin film of oil or glycerine. The freedom from actual contact with the surface of the piece being tested is the feature from which immersion testing derives several advantages.

No special surface preparation is necessary. Tedious and expensive hand work to smooth up the surface of swing or machine skin-ground forging squares is eliminated. Although often not adaptable to automatic scanning, ridges or depressions resulting from grinding present little problem since the angle of entry is merely adjusted for optimum response.

The ordinary hot rolled surface of bars or tubes with tightly adherent scale is very satisfactory. The rough scale lines often present on large rounds do not interfere with good penetration.

Couplant is present as soon as the bar is loaded into the tank, eliminating the delay resulting from the need to brush it on by hand.

Another advantage of the immersion method results from rapid automatic scanning. A motorized search unit positioner follows a scan path under the control of an operator who can constantly observe the oscilloscope screen.

Round bars and seamless tubing are rotated as the positioner advances down the tank, forming a helix which assures complete and uniform coverage.

Squares can be scanned with a pre-set grid pattern actuated through limit switches at the extremes of travel. Varying increments of cross-feed can be set to obtain a scan with the desired overlap.

The better sensitivity and reliability obtained by the immersion method is still another important advantage over contact testing. Higher frequency search units can be used to obtain greater sensitivity when desired. The initial pulse flare is smaller. This represents material immediately beneath the entrant surface of the test piece which is obscured.

Uniformity of couplant and scan permit better monitoring for defect signals exceeding a preset amplitude. The operator can watch the screen while the scan continues automatically although under control for close investigation of questionable areas.

Immersion testing also eliminates crystal wear. The constant rubbing with contact testing, particularly on rough surfaces, results in short crystal life. This is particularly true with the higher frequency, thinner, more fragile crystals. Protective wear plates or boots can be used but add to the initial pulse flare.

Some of the newer synthetic polarized materials which offer superior penetration and resolution can be most effectively used only in immersion testing.

The versatility and interchangeability offered by the immersion method add to its advantages. One search unit can perform several different types of tests.

Higher sensitivity and better resolution may be obtained when thinner sections are tested by change of search units. These changes are readily made without the necessity for preparing fitted adapter shoes for different diameters.

Equipment-operation features of the immersion system offer a wide size range. The Timken Co. designed the 30-ft tank which is used

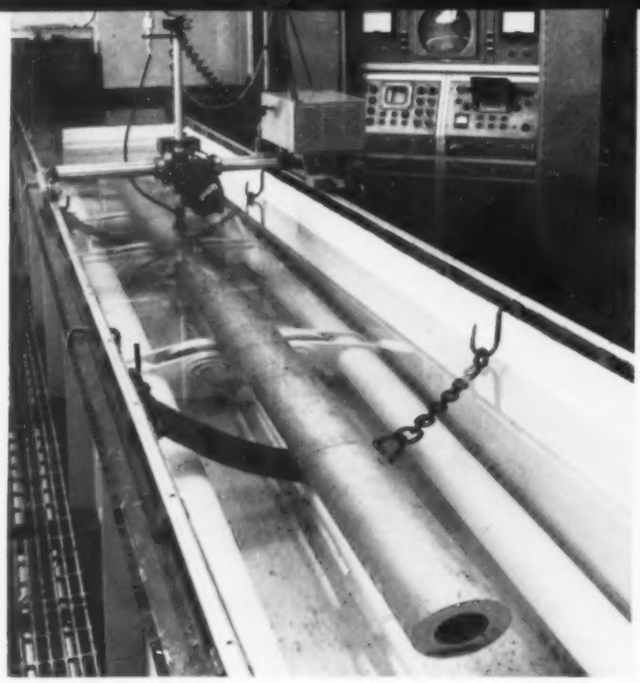


Figure 2 — A large seamless steel tube is in position for testing.

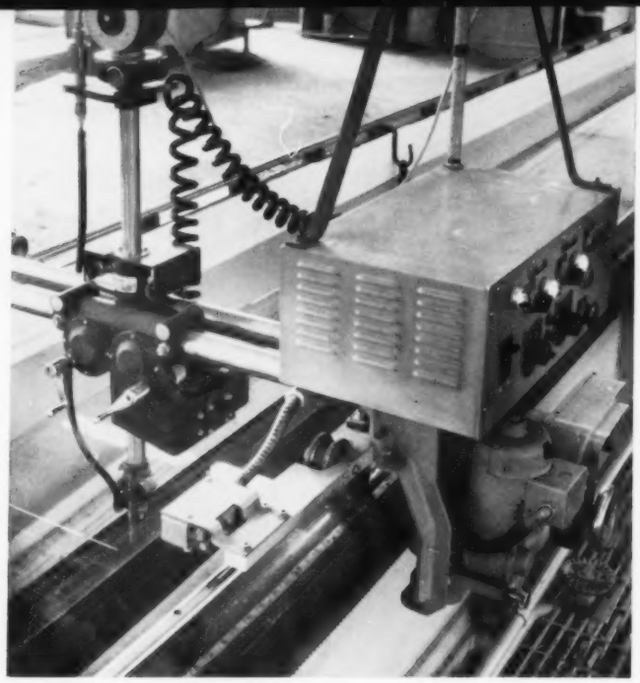


Figure 3 — Semiautomatic search unit positioner is in position over forging square.

for testing of round bars and tubes to 11 in. in diameter and squares up to 12 in. in thickness. Most of the length can be utilized for either rounds or squares.

The turning unit has power-driven rolls at varying positions along its length. It is readily positioned in the tank by shoes that rest on rails welded to the bottom on each side for the full length of the tank. A 3-hp variable-speed drive motor couples to the drive shaft through the end of the tank with provisions for quick disconnection when it is removed. The pair of wide rolls at the drive end serve to hold the calibration standard when testing tubing. Calibration takes place under conditions identical to those of actual testing. The desired scan helix is generated by adjustment of speeds of positioner travel and roll rotation.

Square billets are centered in the tank by loading into two "V" shaped saddles. The fixed saddle in one end can be rotated through 90 degrees by an air cylinder operating a cam. The movable saddle is a follower and can be moved by rolling in the rails that position the round turning unit to accommodate various lengths. After loading the square is turned so one surface is horizontal for testing. After scanning has been done through one surface, the air cylinder is actuated to present an adjacent side in the horizontal position for testing.

The search unit positioner is driven on rails along the length of the tank by a gear and pinion with speeds continuously variable from a few inches to many feet per minute. Limit switches at the extremes of travel actuate varying increments of cross feed as desired when testing square or flat material to obtain the desired overlap. The search unit cable and power supply for the positioner are carried on rolling hangers on an overhead rail.

The search unit can be angled in any direction to obtain the desired beam-entry angle. Peaking up of indication is accomplished by angulation of the search unit and manual movement of the entire positioner.

The ultrasonic instrument is capable of ultrasonic inspection at frequencies from 0.5 to 25 megacycles and can be used for either contact or immersion testing. It features interface gating so that the instrument automatically follows any variation from horizontal in the piece being tested, a variable pulse repetition rate permitting faster no-skip testing, and a versatile alarm and signaling system.

The instrument is housed in a sturdy metal cabinet for protection and provided with a filtered air exhaust system which has extended tube life through cooler operation. A standby circuit was installed by the Timken's electronics maintenance department which further extends tube life by keeping the filament circuit on at all times.

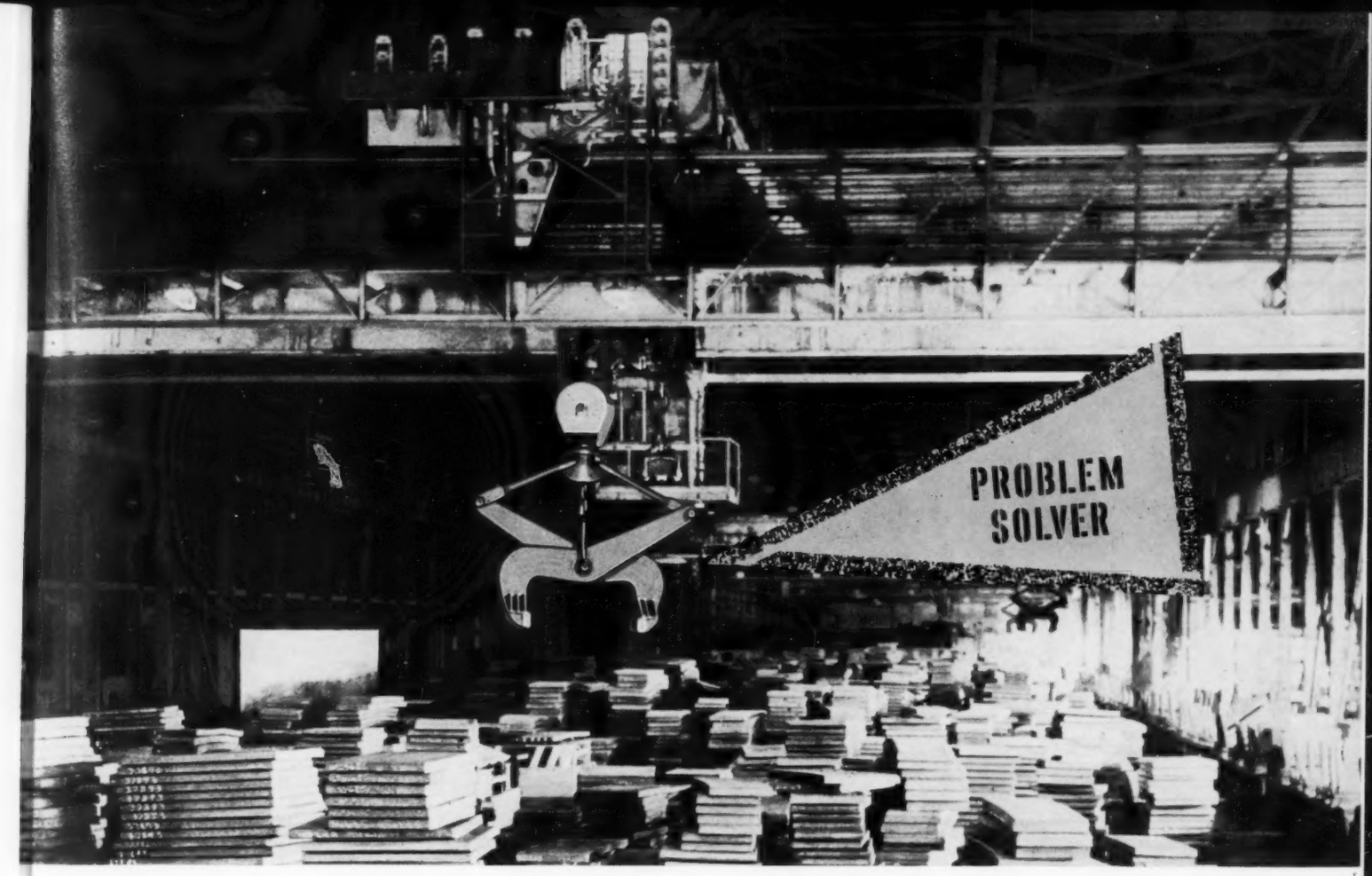
Much of the potential of immersion testing has been realized through design of a unit intended for the ultrasonic inspection of long symmetrical pieces of moderate size. These pieces would normally be handled individually during inspection, so the slight additional handling lost in loading into a tank has been regained through the advantages listed.

Smaller tubes are still more conveniently tested by feeding them past an ultrasonic test station.

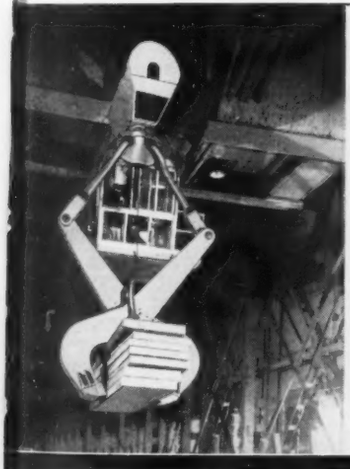
The water is continuously drawn from one end, filtered and returned to the tank. The returning water is actually clearer than the original city water put into the system. Frequent changes of water were necessary before the filter was installed with loss of water as well as any chemical additives and obscuring of visual observation.

A pool cleaner is used for cleaning the bottom of the tank of material too heavy to circulate through the filter, while an overflow skims off floating scum or debris. A household bleach prevents growth of algae. Wetting agents and rust preventatives are added as needed.

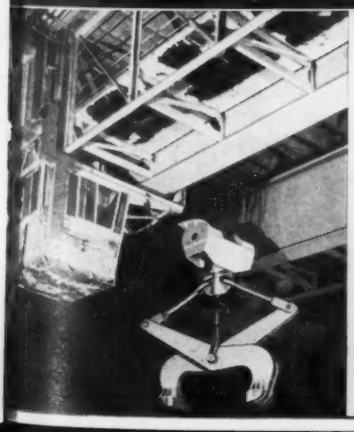
With regard to immersion testing, the company feels that the testing freedom provided by the elimination of crystal contact is invaluable. It provides the advantage of testing through a regular contoured surface with an added advantage of eliminating special surface preparation. ▲



TONGS put a tight grip on safety and economy



The tong jaws open to 76½ inches. They are operated by a separate hoisting unit with cable connected to the pivot point of the tongs.



The cab on these cranes is air-conditioned for operator comfort. It is supported from and travels with the trolley overhanging the rear girder.

Inland Steel Company gave up chains, spacers, and "hooker" manpower in piling slabs in No. 2 Slab Yard at East Chicago, Ind. Time proved the method unsafe for both "hooker" and crane, and inefficient as well. The chains often hung-up and had to be pulled free by the crane operator. Haphazard piling also robbed the yard of storage space.

Inland Steel's plant engineers and Shaw-Box engineers solved the problem. Now five "Shaw-Box" Cranes with unique tongs handle an average of 60,000 tons of slabs a week. They are 120-foot span cranes with 50 and 25 ton hooks, each with a lifting speed of 40 FPM. All slab piling is handled from the cab which travels with the trolley. Slabs are piled far neater than before, and many more can be stored in the same area.

Since their erection in 1957, all five cranes have proved their quality in dependable service. The same creative engineering has made great problem solvers of all types of Shaw-Box Cranes, whether built to AISE specs or individual standards of construction and performance. We welcome the opportunity to serve you.

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- The commutator was turned and undercut and the armature banded before final reassembly of the motor.

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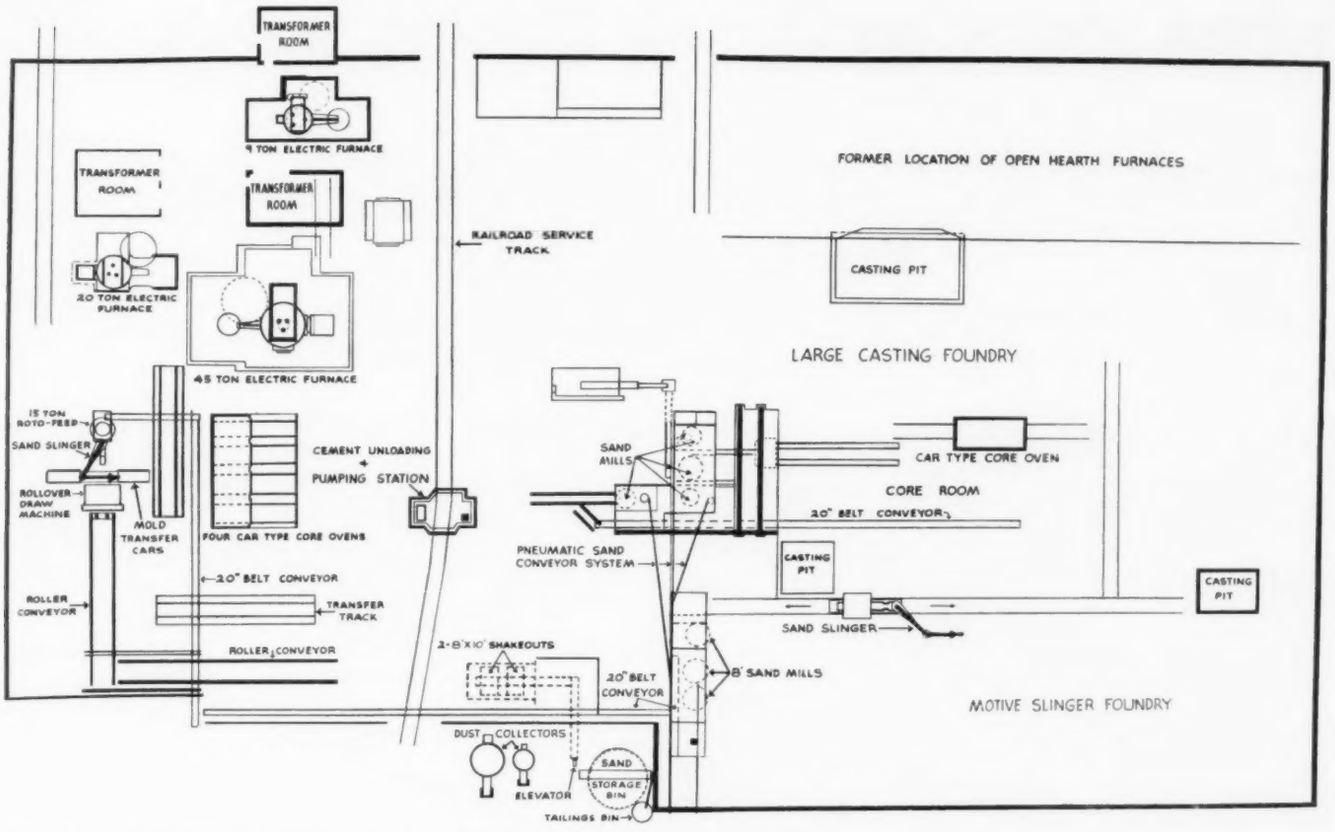

Figure 1 — New floor layout of modernized and expanded Birdsboro Corp., Birdsboro, Pa., steel foundry.

Birdsboro Converts Foundry To Electric Steel Production

BIRDSBORO Corp. has fully converted its steel foundry production from acid open hearth furnaces to basic electric melting process, at Birdsboro, Pa.

Final transition was accomplished with the recent installation of two new electric arc furnaces which triple the company's electric steel melting capacity. Now with a total of three furnaces, all of varying size, the company can melt up to 300 tons of electric steel per day. Its melting capacity for a 20-day working month is 6000 tons.

Birdsboro, formerly limited to carbon and low alloy steels, now can make all foundry type stainless and high alloy steels, thus meeting the rising demand for special, high alloy type castings needed for high pressure, high temperature and corrosion resisting applications.

The company now can produce an unusually wide variety of castings ranging in size from 50 to 75,000 lb, and in some case, up to 100,000 lb.

Installation of the second and third electric furnaces also enables Birdsboro to produce alloy steel melts as small as four tons, compared with minimum melts of eight tons formerly practicable. Both new furnaces, added at a cost of $600,000, have been installed with the original electric arc furnace in the company's slinger area. The smaller of the new furnaces has an 8-ft diam shell and a melting range of four to nine tons. The average heat is expected to be about five tons. Melting rate of the furnace is two tons per hr.

A charge of 20 to 45 tons can be handled in the larger furnace, which has a 13½-ft diam shell. Average heat is estimated at 28 tons, and the average melting rate at seven tons per hour.

Birdsboro's existing electric furnace, in operation for five years, is designed for the intermediate melting range of eight to 20 tons. It has an 11-ft shell diameter, and an average heat of 15 tons. Average melting rate of the furnace is five tons per hour.

Work is now underway to remove the foundry's three open hearth furnaces.

In place of the open hearth furnaces, Birdsboro plans to install additional production type mold producing equipment, which is expected to increase the foundry's miscellaneous casting capacity from 1050 to 1250 tons per month.

A new sand handling system also has been added. It is expected to provide a 50 to 60 per cent savings in sand-handling costs while, at the same time, permit production of higher quality castings than formerly possible. Base sand is pneumatically transported in overhead pipes at the rate of 25 to 30 tons per hour. A special dryer protects the sand from wet and cold, as do two new 600-ton storage silos.

Other major additions include: two new high temperature, car-bottom type heat treat furnaces of 50-ton and 100-ton capacities; recirculating water quench facilities with 15,000-lb capacity; a 50-ton and 10-ton overhead crane; a four-compartment core oven; an automatic shakeout machine with dust collector; a stationary sand slinger, and a six-ton mold roll-over draw machine. ▲

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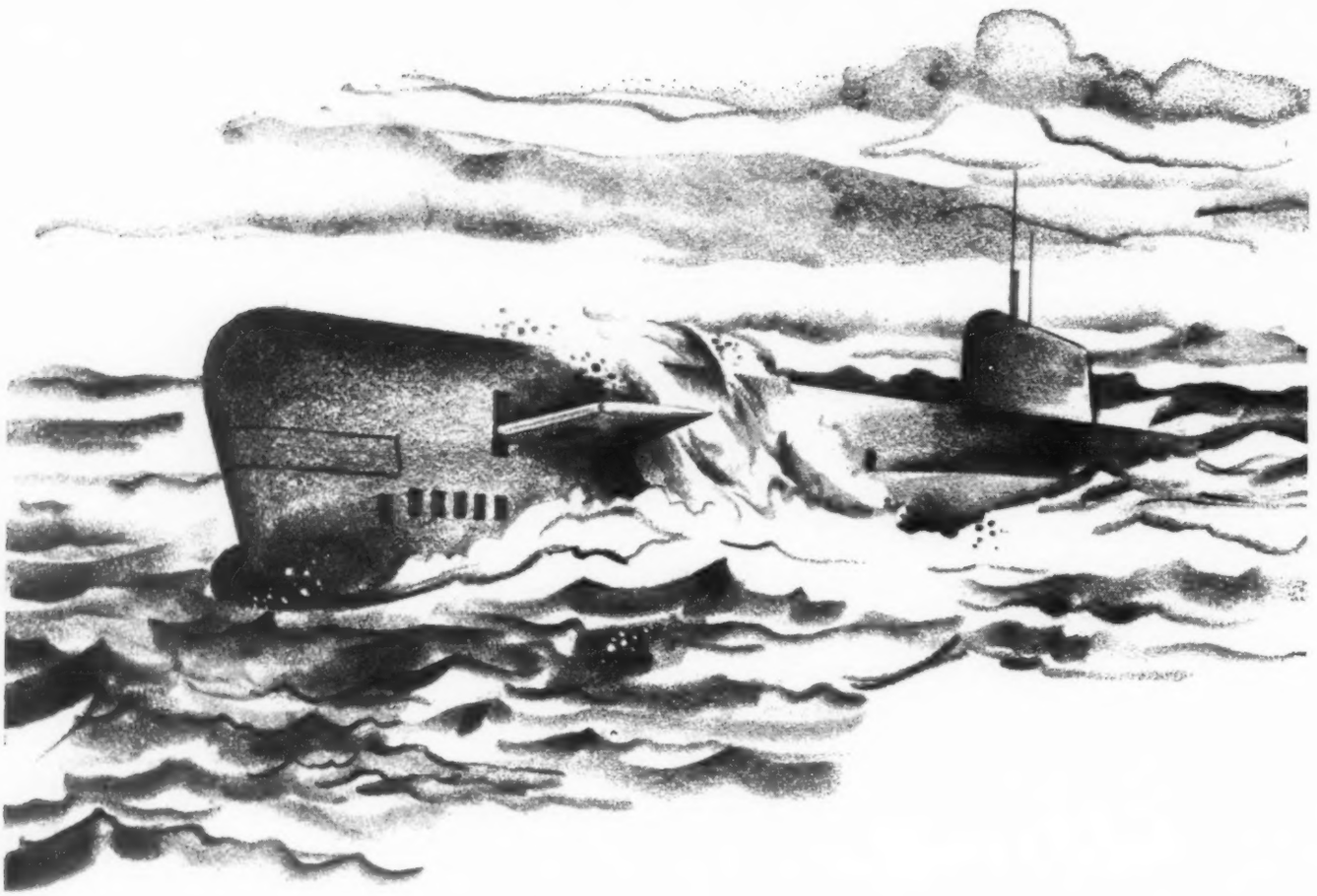

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Republic Installs 74-In. Sheet Polisher

A 74-IN. wide pinch roll sheet polisher has been installed by Republic Steel Corp. at its Enduro Div., in Massilon, Ohio. Designed and built by Acme Manufacturing Co. of Detroit, Mich., this is the largest machine of its kind ever built. In addition, the machine incorporates several unique features. These are:

1. Steel can be polished tip-to-tip without the leave-off marks normally encountered in reciprocating bed type machines.
2. Complete flexibility is provided. The machine can be selectively used as a through feed machine for high production runs, or as a reciprocating machine for short run work.
3. Resquared sheets can be processed tip-to-tip.

The machine, Figure 1, features an unusual motorized lead-in and run-out conveyor and pinch roll drive arrangement that permits tip-to-tip polishing within ⅛-in. of each edge of the sheet. Sheets ranging in size from 4 to 20 ft long and 0.015-in. to 0.250-in. thick are polished to either No. 3 or No. 4 finish with four passes back and forth through the polishing mill. Adjustable traverse speeds from 20 to 60 fpm are being utilized. About 85 per cent of the polishing work is done on one side of the sheet. The balance is done on both sides.

A sheet to be polished is loaded from the side onto the ball transfers on the lead-in conveyor. With the sheet properly positioned, the ball transfers are lowered and the conveyor carries the work into pinch rolls that carry the sheet through the grinder in contact with the abrasive belt and a billy roll underneath the belt.

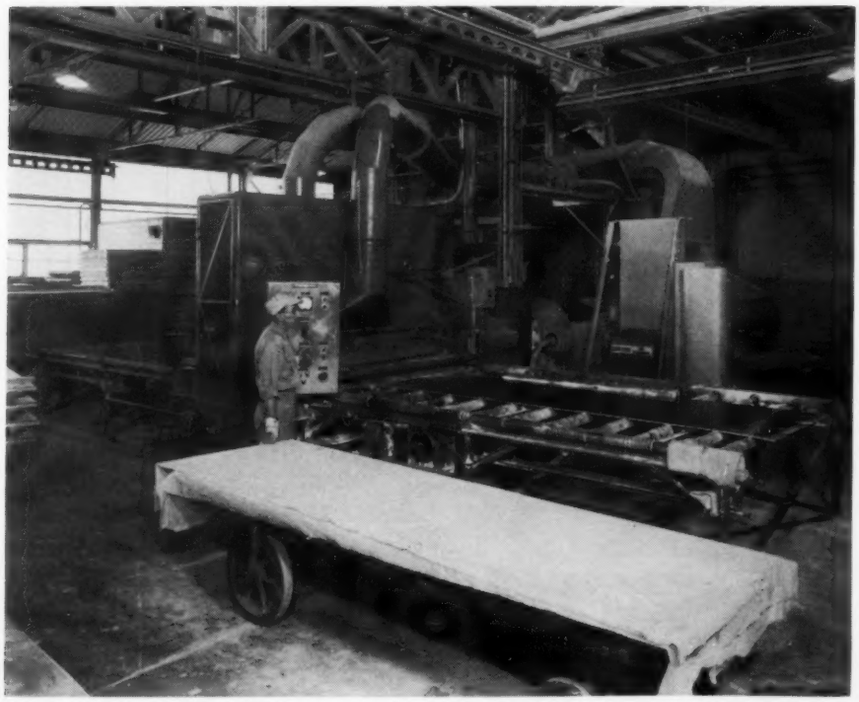
The sheet is fed out by another set of pinch rolls behind the belt head onto the run-out conveyor. When the sheet passes through the belt unit an electric eye causes the motor drive for the pinch rolls (which also drive both conveyor rolls) to reverse. Thus the sheet is fed back through the polishing unit automatically. At the end of the reverse-travel process, the ball transfers raise and the sheet can be unloaded at the side of either conveyor.

The sheet is polished its entire length. No loss of stock (usually 2-in. on each end with gripper finger transfer arrangements) is incurred by this method of processing. The electric eye arrangement is designed so that the billy roll contacts the sheet ⅛-in. behind the edge. This permits a No. 4 finish to be readily produced by the machine.

The Acme 74-in. polishing mill has a 200-hp motor that drives the abrasive belt at speeds ranging from 3200 to 3600 fpm. The pinch rolls are powered by a separate motor. The base and column of the machine are steel weldments. The spindle housing is cast iron. A separate base is provided for the motor drive. Pinch rolls are rubber covered, top and bottom. Oil mist lubrication is provided for both main spindle bearing and idler roll bearings.

A 150-grit belt is used on sheets requiring a No. 4 finish. A 100-grit belt provides the No. 3 finish requirements. ▲

Figure 1 — Unit is polishing a stainless steel sheet to a No. 4 finish on an Acme polishing mill at Republic Steel Corp.'s Massillon, Ohio, plant.



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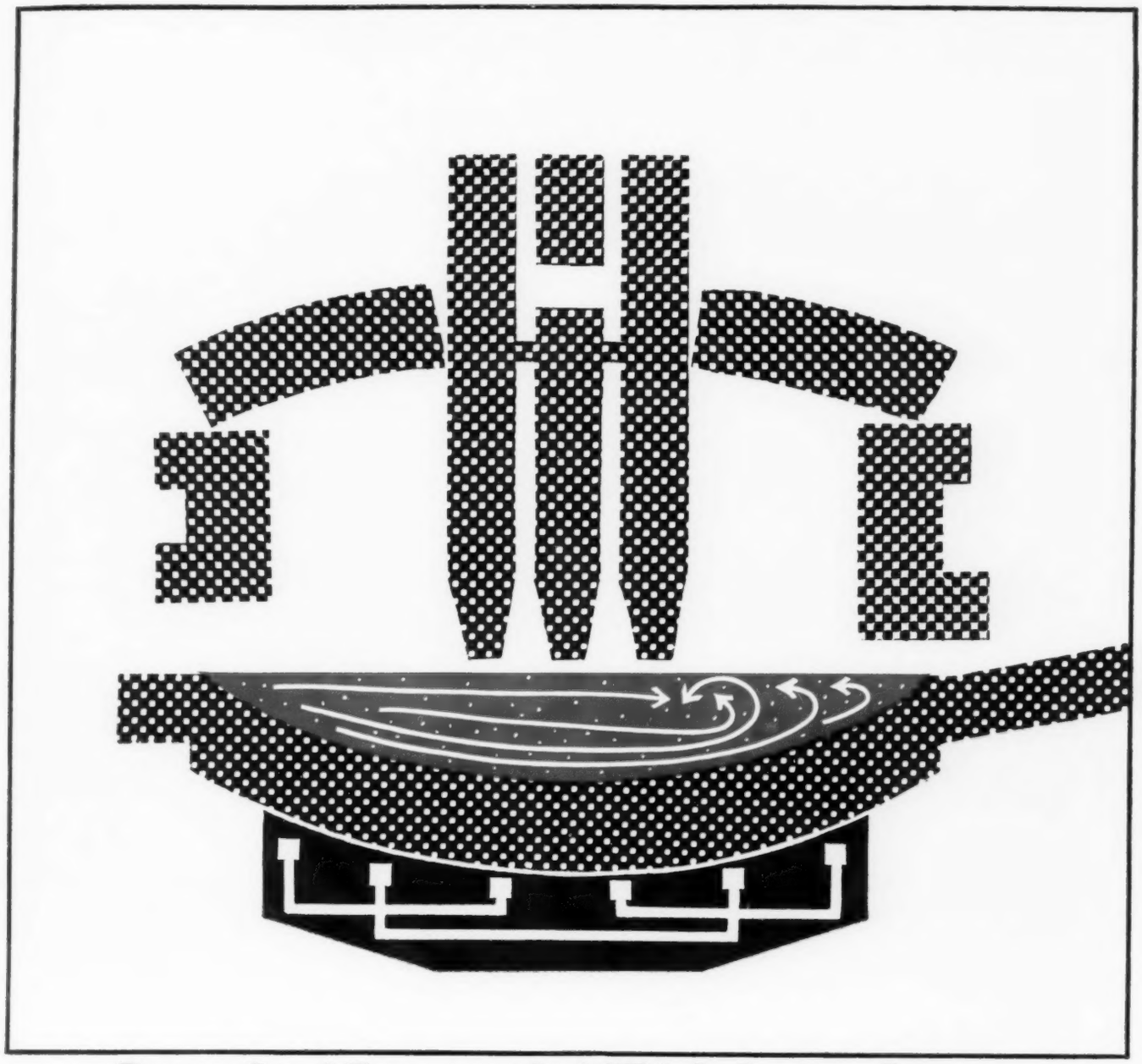

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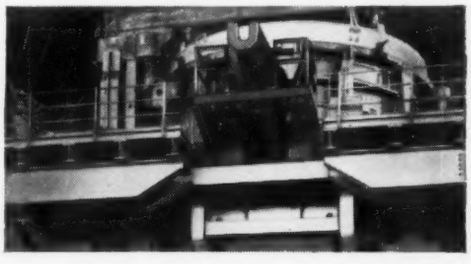

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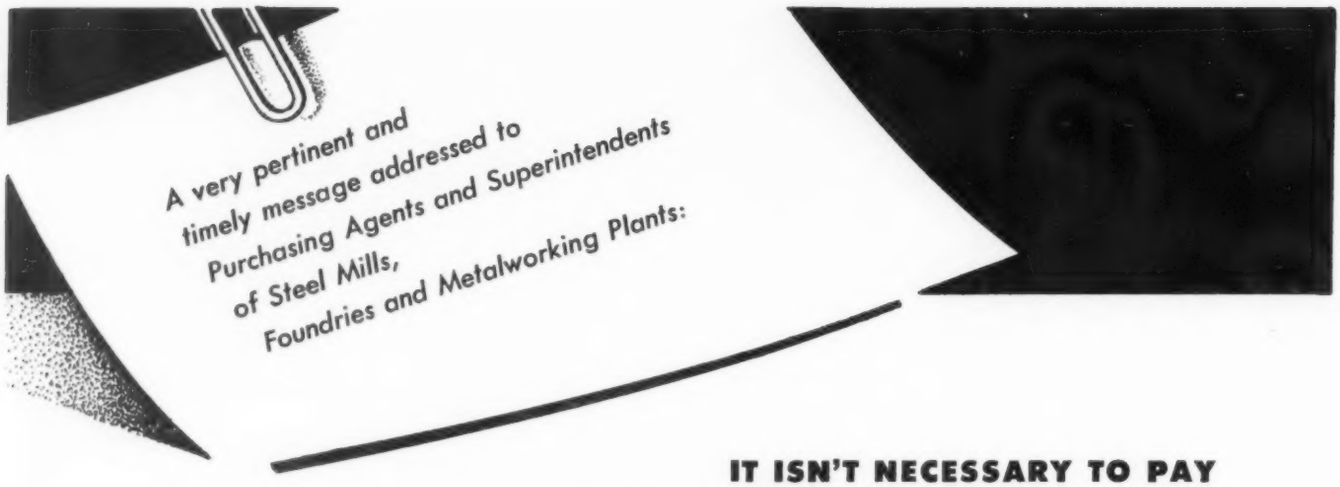

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Date-line Diary...

January 2

Δ The AISI reports that production of steel for the week beginning January 1, totaled 1,361,000 tons (this is equal to 47.8 per cent of 1960 capacity), compared with 1,103,000 tons the previous week and 2,715,000 tons one year ago. Index of production for the week is 73.1.

Δ Firth Sterling reports for the fiscal year ending September 30, 1960, sales totaling $22,089,597, and a loss of $587,548.

January 4

Δ The Bureau of the Census reports that shipments of iron and steel castings for October, 1960, totaled 1,071,344 tons compared with 1,067,843 tons in September, 1960, and 1,052,630 tons in October, 1959.

January 5

Δ Joint report from American Iron Ore Assn. and AISI indicates receipts of iron ore and iron ore agglomerates in the U. S. for November, 1960, totaled 5,866,596 gross tons compared with 11,603,915 tons in November, 1959. Stocks on hand as of November 30, 1960, totaled 70,361,708 tons compared with 57,536,917 tons on November 30, 1960. Blast furnaces in operation on November 30 were 130 of the total 258. On November 30, 1959, 221 blast furnaces were in operation.

Δ The American Iron Ore Assn. reports that there were no shipments of iron ore down the Great Lakes in December, 1960, compared with 3,175,949 tons in December, 1959. Total shipments in 1960 were 69,631,789 gross tons compared with 46,881,450 in 1959.

Δ The Bureau of Mines reports that production of Pennsylvania anthracite in December, 1960, totaled 1,724,000 net tons compared with 1,626,000 tons in November, 1960, and 1,965,000 tons in December, 1959.

January 6

Δ Treasury figures showed that sales of U. S. savings bonds in 1960 totaled $4,400,000,000, an increase of $30,000,000 over 1959 sales; redemptions in 1960 amounted to just under $5,000,000,000, down $523,000,000 from the 1959 figure.

Δ The AISI reports that the steel industry's payroll for hourly and salaried workers in November, 1960, totaled $270,442,490 compared with $284,815,307 in October, 1960; total employed numbered 499,087 in November compared with 516,164 in October; payroll cost per hour worked by hourly employees, $3.337 in November, against $3.321 in October, not including 48¢ supplemental employee benefits. Average hours per week worked were 34.0 in November, 1960, compared with 34.1 in October, 1960.

January 9

Δ The AISI reports that production of steel for the week beginning January 8 totaled 1,482,000 tons (this is equal to about 51.6 per cent of 1960 capacity), compared with 1,361,000 tons the previous week and 2,727,000 tons one year ago. Index of production for the week is 79.6.

Δ Dealer deliveries of autos for December, 1960, totaled 487,950 cars, up 35 per cent over December, 1959, deliveries.

January 10

Δ The Eisenhower administration forecast a budget surplus of less than $200,000,000 for the fiscal year ending June 30, 1961; but predicted a surplus of $1,500,000,000 for the year starting July 1, 1961.

Δ The Aluminum Assn. reports that shipments of aluminum sheet and plate in November, 1960, totaled 106,450,000 lb compared with 104,148,000 lb in October, 1960; shipments of aluminum foil in November, 1960, totaled 19,752,604 lb compared with 21,830,635 lb in October, 1960.

January 11

Δ The dollar price of gold continued to inch upward on the London bullion market, advancing to $35.72½ an ounce, which compares with a high of $41 an ounce set in mid-November.

Δ The Commerce Dept. reported that seasonally adjusted retail sales in December, 1960, totaled just under $18,200,000,000.

Δ The Bureau of the Census reports that shipments of commercial steel forgings in November, 1960, totaled 92,038 net tons compared with 97,448 tons in October, 1960, and 87,253 tons in November, 1959.

January 12

Δ The Bureau of the Census reports that shipments of titanium mill products in November, 1960, equaled 1,176,833 lb compared with 1,075,978 lb in October, 1960, and 474,312 lb in November, 1959.

Δ Directors of both the B&O and the C&O railroads, at separate meetings, adopted a joint resolution favoring affiliation of the two carriers.

Δ The AISI reports that steelmaking furnaces in the U. S. produced 99,277,760 net tons of ingots and steel for castings during 1960, an increase of over 5,800,000 tons of the 1959 output. The index of production in 1960 equaled 118.2 compared with 111.6 in 1959.

Δ Copper prices were cut 1¢ a lb to 29¢ by major custom smelters; however, large copper producers indicated they would hold firm at 30¢.

January 16

Δ Kaiser Steel Corp. and USW have proposed that a 9-member committee of management, labor and the public permanently handle labor problems. During contract negotiations, they suggest the committee could act as observers and, if necessary, as mediators.

Δ The Labor Dept. reported that unemployment climbed to 4,540,000 in the month ended December 15, up 509,000 over the mid-November total.

Δ Kaiser Steel cuts prices of electric-weld pipe ranging from 5⁹⁄₁₆ to 18-in. diam by about $20 a ton to meet price competition of other pipe producers in the West and Midwest.

Δ The Commerce Dept. reported that exports of steel in November, 1960, rose to 284,000 tons, up 53,000 tons over October, 1960; imports increased to 199,000 tons in November, 1960, an increase of 19,000 tons over October, 1960.

△ The Bureau of the Census reports that net shipments of aluminum pig and ingots in November, 1960, totaled 132,932,000 lb, compared with 123,958,000 lb in October, 1960; shipments of magnesium mill products in November, 1960, totaled 1,582,000 lb, compared with 1,679,000 lb in October, 1960.

△ The consumption of scrap in the United States in November, 1960, totaled 3,940,000 gross tons compared with 4,375,871 tons in October, 1960; consumption of pig iron in November, 1960, totaled 3,675,000 gross tons compared with 4,017,508 tons in October, 1960.

△ The AISI reports that production of steel for the week beginning January 15 totaled 1,499,000 tons (or about 52.2 per cent of 1960 capacity), compared with 1,482,000 tons the previous week and 2,727,000 tons one year ago. Index of production for the week is 80.5.

January 17

△ Youngstown Sheet and Tube disclosed it is spending nearly $6,000,000 to rebuild an 84-coke oven battery at its Brier Hill works in Youngstown, mainly to reduce air pollution.

△ Inland Steel revised its price of wide tinplate steel for can manufacturers, reducing by 15¢ or less than two per cent, the price of 33½ to 36-in. sheet.

△ The ARCI reported that deliveries of new freight cars in December, 1960, totaled 4272 compared with 3799 in November, 1960, and 3032 in December, 1959. Orders in December, 1960, totaled 2705 compared with 3680 in November, 1960, and 10,555 in December, 1959. Backlog of cars on order as of January 1, 1961, totaled 21,070 compared with 22,781 on December 1, 1960, and 43,870 on January 1, 1960. Deliveries in 1960 totaled 57,047 compared with 37,819 in 1959; orders in 1960 totaled 36,368 compared with 56,489 in 1959.

January 18

△ The Census Bureau reported that private housing starts in December, 1960, declined to a seasonally adjusted annual rate of 999,000, down 18 per cent from November, 1960 and 32 per cent below December, 1959. Total for the year 1960 was 1,240,000 units compared with 1,516,800 units in 1959.

△ Bethlehem Steel and National Steel cut supplementary unemployment benefits to laid-off workers; United States Steel, which cut supplemental benefits to 67½ per cent of normal in December, has reduced them to 60 per cent in January. Bethlehem's cut was to 67½ per cent and National's Great Lakes cut was to 75 per cent of normal.

January 19

△ The Commerce Dept. reported that personal income in December, 1960, fell to a seasonally adjusted annual rate of $406,700,000,000 down $2,300,000,000 from the revised November, 1960, level.

January 20

△ The AISI indicates that steel companies plan to spend about $1,200,000,000 in 1961 on new equipment and construction compared with outlays of $1,480,000,000 in 1960.

January 23

△ The AISI reports that production of steel for the week beginning January 22 totaled 1,466,000 tons (this is equal to 50.9 per cent of 1960 capacity), compared with 1,499,000 tons the previous week and 2,717,000 tons one year ago. Index of production for the week is 78.7.

△ The AISI reported that output from U. S. blast furnaces in 1960 totaled 67,320,129 net tons, exceeding the 1959 production by 10.8 per cent; preliminary data shows stainless steel output in 1960 totaled 1,003,637 net tons, compared with 1,100,000 tons in 1959; also (preliminary) production of alloy steel other than stainless totaled 7,392,171 net tons in 1960 compared with nearly 7,800,000 tons during 1959.

△ The Commerce Dept. reported that consumer spending in the final quarter of 1960 rose to a seasonally adjusted annual rate of $332,000,000,000, compared with $328,300,000,000 in the third quarter; for the year spending averaged a record $328,200,000,000, compared with $313,800,000,000 in 1959.

△ The Edison Electric Institute reported that the electric industry increased its generating capacity to 175,000,000 kw in 1960.

January 24

△ Labor Secretary Goldberg reported that workers drawing jobless benefits in the week of January 7 rose to 3,289,000, an increase of 228,900 from the previous week.

January 25

△ The Bureau of Statistics reported that Canadian steel production in the week ended January 21, 1961, totaled 105,456 tons compared with 110,720 tons in the previous week and 127,801 tons in the comparable week of 1960. On the basis of the 1957–59 average, the bureau's index stood at 110 for the latest week.

△ Can Manufacturers Institute, Inc., reports that canmakers consumed 317,940 tons of steel in November, 1960, an increase of 6.2 per cent over November, 1959, consumption. Aluminum cans totaled 1468 tons.

△ United Engineering and Foundry Co. reports that in 1960 net sales totaled $82,149,236, net profits were $4,958,294 or $1.93 a share; this compares with 1959 sales totaling $62,731,363, net income of $6,073,193 or $2.38 per common share.

△ The AISI reported that production of pig iron in December, 1960, totaled 3,876,776 net tons, compared with 4,200,000 tons in November, and 7,600,000 tons in December, 1959.

△ The AISC reported that shipments of fabricated structural steel in December, 1960, totaled 246,196 tons, compared with 288,685 tons in November, 1960, and 235,688 tons in December, 1959. Bookings in December, 1960, totaled 222,478 tons compared with 240,347 tons in November, 1960, and 366,125 tons in December, 1959. Backlog as of December 31st stood at 2,064,420 tons. Shipments in 1960 totaled 3,436,216 compared with 2,904,409 tons in 1959; bookings in 1960 totaled 3,210,489 tons compared with 3,222,858 tons in 1959.

January 26

△ Resistance Welder Mfr. Assn. reports that shipments of resistance welding equipment by members in 1960 totaled more than $29,000,000, 15.4 per cent over the 1959 total. Backlogs at December 31, 1960 amounted to nearly $9,750,000.

△ The Aluminum Assn. reports that primary aluminum production in 1960 totaled 2,014,499 short tons compared with 1,954,112 tons in 1959.

△ The National Machine Tool Builders Assn. reports that new orders of metal cutting and forming types machine tools in December, 1960, totaled $59,250,000 compared with $49,950,000 in November, 1960;

STEEL COMPANIES QUARTERLY FINANCIAL REPORTS—PERIODS ENDING DECEMBER 31, 1960

	Period	1960 Net sales	1960 Net profit	1960 Earnings per share	1959 Net sales	1959 Net profit	1959 Earnings per share
Acme Steel Co.	4th quar.	$ 28,286,661	$ (206,680)	...	$ 28,136,775	$ 655,198	$0.20
	Year	140,723,383	2,202,975	0.60	133,835,021	3,616,481	1.17
Alan Wood Steel Co.	4th quar.	....	314,000	0.37	....	1,774,000	2.46
	Year	62,805,000	1,437,000	1.72	81,074,000	4,856,000	6.63
Algoma Steel Corp. Ltd.	Year	....	13,253,000	2.30	....	17,606,000	3.05
Allegheny Ludlum Steel Corp.	4th quar.	53,092,224	2,569,723	0.66	49,417,731	2,834,976	0.73
	Year	238,772,955	8,750,209	2.25	230,664,649	11,290,664	2.92
Armco Steel Corp.	4th quar.	703,311,000	17,032,000	1.15	241,779,522	17,618,285	1.19
	Year	937,967,000	70,459,000	4.76	1,022,428,742	77,064,249	5.21
Bethlehem Steel Co.	4th quar.	450,286,348	27,200,408	0.56	408,897,949	33,003,943	0.69
	Year	2,178,120,164	121,179,549	2.52	2,055,720,850	117,235,859	2.44
Byers, A. M. Co.	4th quar.	4,640,918	76,600	0.08	6,666,480	121,000	0.14
Carpenter Steel Co.	2nd quar.	15,294,204	523,081	0.27	23,378,614	2,224,479	1.19
The Colorado Fuel and Iron Corp.	4th quar.	....	(1,602,000)	(0.43)	....	(1,999,729)	(0.56)
	Year		(1,196,625)①	(0.41)①		4,364,554	1.04
Continental Steel Corp.	4th quar.	....	....	0.97	....	....	1.75
	Year	46,000,000	....	...	57,083,835	5,657,052	5.47
Copperweld Steel Co.	Year	114,795,018	2,441,781	2.08	138,364,827	5,972,457	5.00
Crucible Steel Co. of America	Year	210,900,000	1,240,000	0.19	219,229,082	6,106,443	1.50
Firth Sterling, Inc.	1st quar.	4,913,100	(61,300)	...	6,187,600	19,100	0.01
Granite City Steel Co.	4th quar.	27,005,595	1,693,591	0.39	44,766,372	4,511,666	1.00
	Year	137,328,000	11,121,000	2.59	164,371,219	16,142,341	3.76
Inland Steel Co.	4th quar.	156,969,911	8,847,739	0.51	138,042,297	13,630,758	0.78
	Year	755,721,239	47,050,611	2.68	713,215,002	48,354,030	2.77
Jones & Laughlin Steel Corp.	4th quar.	152,968,000	3,534,000	0.40	146,230,000	3,744,000	0.43
	Year	778,752,000	33,153,000	4.04	765,672,000	29,485,000	3.58
Kaiser Steel Corp.	Year	207,278,027	(8,215,842)	(3.49)	202,126,940	(7,401,076)	(3.26)
Keystone Steel & Wire Co.	2nd quar.	21,258,437	812,533	0.43	33,651,303	2,460,693	1.31
	1st half	43,838,536	1,508,751	0.80	63,328,889	4,274,257	2.28
National Steel Corp.	4th quar.	139,356,596	6,574,800	0.86	169,803,514	12,614,652	1.66
	Year	697,063,036	41,937,235	5.53	736,978,650	54,897,360	7.28
Phoenix Steel Corp.	Year	....	(1,922,289)	...	....	2,108,754	2.03
Pittsburgh Coke & Chemical Co.	Year	....	1,334,000	0.78	....	2,725,000	1.98
Pittsburgh Steel Co.	Year	143,198,821	1,026,476	...	149,918,633	(994,310)	
Republic Steel Corp.	Year	1,064,143,930	52,846,373	3.36	1,083,990,121	53,890,116	3.43
Sharon Steel Corp.	Year	116,093,716	1,131,882	1.02	119,760,979	2,145,593	1.94
Steel Co. of Canada, Ltd.	Year	281,967,392	21,355,651	4.92	321,544,223	32,878,195	7.58
United States Steel Corp.	4th quar.	723,296,653	58,632,841	0.97	748,841,160	30,162,326	0.44
	Year	3,698,494,931	304,520,681	5.17	3,643,040,035	254,563,401	4.25
Vanadium-Alloys Steel	6 mos.	....	378,458	0.59	....	1,256,932	2.01
Washington Steel Corp.	4th quar.	....	244,837	0.37	....	660,850	1.03
Wheeling Steel Corp.	Year	227,884,000	8,277,000	3.14	211,634,000	7,033,000	2.53
Woodward Iron Corp.	Year	....	4,976,000	1.94	....	5,486,357	2.13
Youngstown Sheet and Tube Co.	Year	584,300,280	25,719,166	7.38	617,889,289	30,956,040	8.90

① Excludes losses from sale of Claymont plant. Figures in parentheses denote loss.

shipments in December, 1960, totaled $60,450,000 compared with $48,550,000 in November, 1960. For the year 1960 new orders totaled $653,400,000 shipments $650,900,000.

Δ Westinghouse Electric Corp. reported for the year 1960 sales totaled $1,955,731,000, net income of $79,057,000 or $2.22 a common share, compared with 1959 sales totaling $1,910,730,000, net income in 1959 per common share was $2.22.

January 27

Δ F. W. Dodge Corp. reports that contracts awarded in December 1960, totaled $2,717,701,000, 22 per cent over December, 1959. Total contracts for the year 1960 totaled $36,317,629,000, slightly ahead of the 1959 total.

Δ The Bureau of the Census reports that shipments of nonferrous castings in November, 1960, totaled 176,669,000 lb compared with 183,630,000 lb in October, 1960.

January 30

Δ Government figures showed that consumer prices rose to 127.5 per cent of the 1947–49 average in December, 1960, a gain of 0.1 per cent over November, 1960. At the close of 1960, living costs were 1.5 per cent higher than at the beginning of the year.

January 31

Δ The National Assn. of Home Builders reported that home mortgage foreclosures in 1960 totaled 48,000 compared with 44,000 in 1959.

Δ Koppers Co. report for 1960 sales totaling $302,500,000, net income of $7,474,000 or $3.06 per share, compared with sales of $241,700,000, net income of $5,832,000 or $2.28 a share in 1959.

Δ The Commerce Dept. reported that manufacturing firms new orders in December, 1960, declined to $28,700,000,000, about one per cent below the November, 1960 total; sales also experienced a one per cent drop; and manufacturers reduced inventories another $350,000,000, resulting in a total reduction of $1,400,000,000 since mid-1960.

Δ Customer smelters increase scrap copper buying price ¼¢ to 22¾¢ a lb.

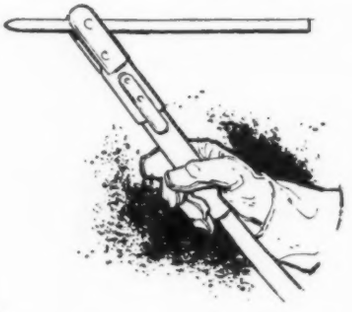
Δ The Commerce Dept. reported that shipments of copper-base mill and foundry products in the third quarter of 1960 totaled 1,014,000,000 lb compared with 1,109,000,000 lb in the second quarter, 1960 and 1,170,000,000 in the third quarter of 1959.

Δ The Census Dept. reported that construction outlays in January, 1961, declined to a seasonally adjusted rate of $55,300,000,000, compared with $56,400,000,000 in December, 1960. Actual value of new construction in January, 1961, totaled $3,800,000,000, 15 per cent less than in December, 1960.

1.
This is the partially used Kostkutter Rod as it is held in the torch.

2.
Now the stub is ready for insertion of the new rod. Note that the stub is clamped far back and that the operator's hand is on the torch handle.

3.
Operator now joins new rod to stub by inserting tapered end firmly into hole and giving rod a slight twist. Pressure of torch jaws is sufficient to hold stub during seating—*do not use violent pressure or impact to drive in rod.*

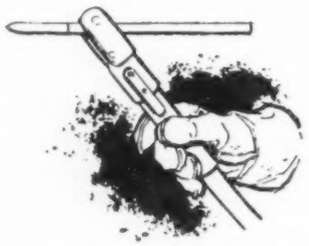


4.
New rod is now attached firmly to stub and ready for the first move.

get maximum savings from your

kostkutter* rods

Speer's new Kostkutter Rods are designed to save you 20-25% over conventional cutting carbons. Their revolutionary design allows new rods to be joined to stubs... virtually eliminating waste. Their use prolongs torch life, too, since the hot spot can always be kept a safe distance from the clamping device.
By following the simple procedures illustrated here, you can get maximum use and economy from your rods.



5.
This is the proper position of torch jaws after they are moved behind joint. This position also *keeps air blast off joint*—essential to prevent stub loss. The old stub should be burned to minimum length before moving torch jaws just behind joint.

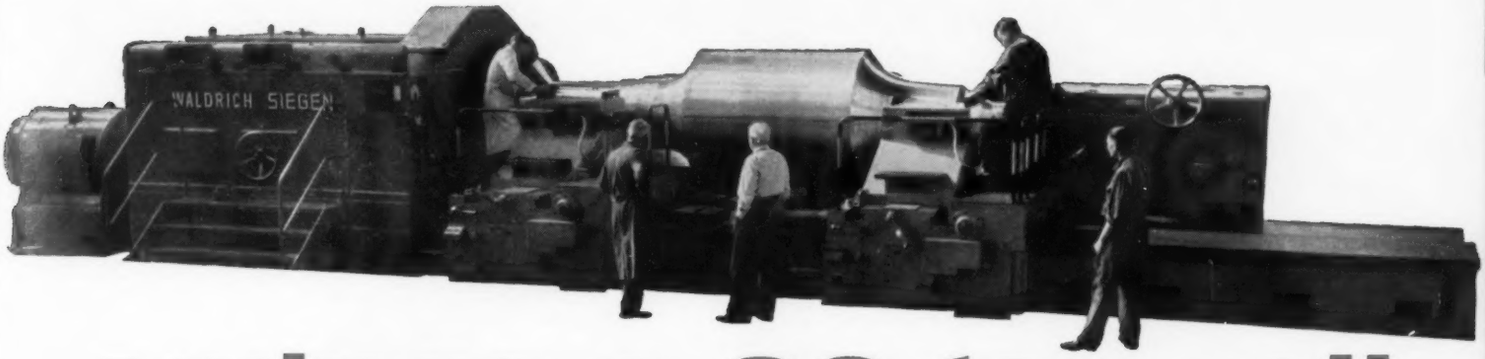
Kostkutter Rods are copper-plated (except tapered sections) after shaping rod ends, thus insuring perfect contact between rods. Available only from Speer, Kostkutter Rods come in diameters of ½", ⅝", ¾" and 1". Standard cutting carbons are also available at slightly lower prices.

**Patent applied for*

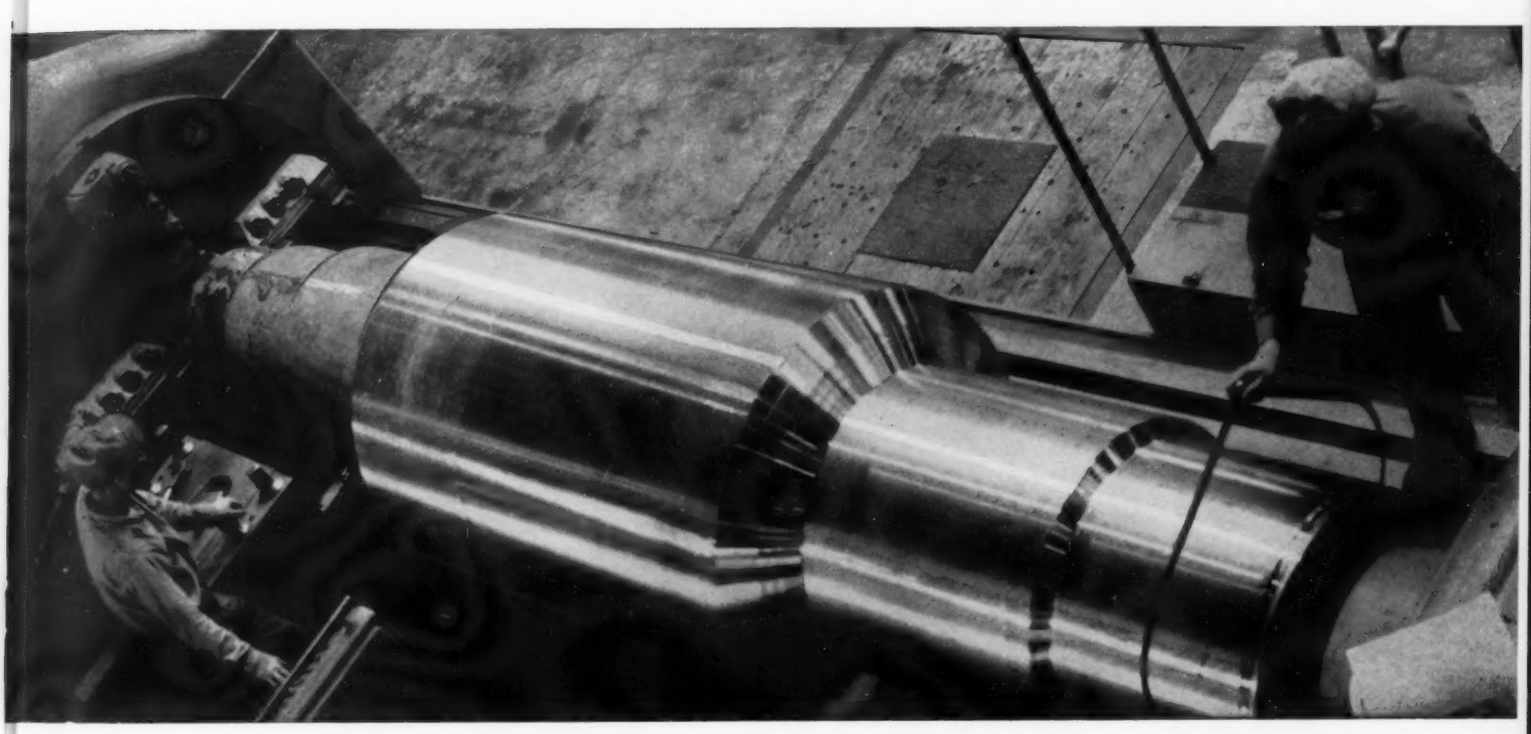
SPEER Carbon Co.

Carbon Products Division St. Marys, Pennsylvania

this Waldrich giant



swings a 90-ton roll



—cuts rough turning time 75%

You're looking at the business end of a Waldrich-Siegen Roll Turning Lathe, built to turn a workpiece as long as 30 ft., as fat as 63 in. in diameter, and as heavy as 90 tons!

Right now, you're seeing it in action at the Ohio Steel Foundry Co., Lima, Ohio, biting into a 57-ton, 98-in. long roll, with a 53-in. O.D. In just three passes, its hungry cutters will shear 15 inches of steel off this diameter. Before it's through, 12 tons of turnings will come off.

This job used to take 68 hours at Ohio Steel Foundry. The husky Waldrich breezes through it in just 16½ hours flat.

It takes plenty of muscle to peel through so much steel and the Waldrich has it, delivering 250 horsepower to the spindle. Speed is set at the selector wheel, feed at each of the two independent carriages.

And here's an interesting economy note: chips from the Waldrich lathe are large enough to be remelted, unlike finer chips from other lathes that oxidize too quickly. Ohio Steel Foundry collects a bonus of $15 on every ton salvaged.

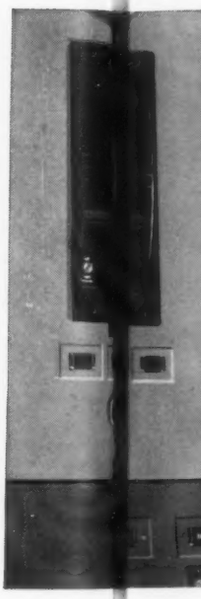
Three different size Waldrich lathes are now in operation at this plant, turning workpieces with maximum O.D.'s of 36″, 48″ and 63″. Maybe one of these sizes is the answer to your roll turning needs. It's easy to find out. Write today for complete details on these heavy producers.

WALDRICH SIEGEN

american waldrich mfg. corp.

1232 PENN AVENUE, PITTSBURGH 22, PENNSYLVANIA

Control your basic oxygen process with



a Honeywell instrumentation system

The new basic oxygen process for steelmaking requires fast, precise, integrated control of all variables—oxygen pressure and flow in particular. Honeywell gives you a *complete system* of instrumentation—from primary elements to computer—tailored to the process and to the individual needs of your mill. This system brings extra advantages to the oxygen process.

Honeywell's application engineers will help you choose the proper components for your process from the broad line of Honeywell products—products proved throughout industry. Honeywell instruments, with electric or pneumatic control, are available for all parts of the oxygen process operation.

The Honeywell all-electric oxygen flow computer measures, records, and controls oxygen mass flow rate—automatically and continuously totalizing the oxygen used for all heats in all converters. The computer compensates automatically for temperature and pressure variations—and delivers the exact number of pounds of oxygen the charge requires.

The Honeywell instrumentation system holds temperature, pressure, humidity, and electrical power at optimum levels at every step of the process—protecting all the equipment—process vessel linings, exhaust gas hood, ducts, and precipitator.

Custom-designed Honeywell systems for the basic oxygen process are now performing in major steel mills across the country. The mills gain Honeywell's unique experience in controlling the oxygen process as well as the assurance of reliable, single-source responsibility for the entire system. Your nearby Honeywell field engineer can give you complete details. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Penna. In Canada, Honeywell Controls, Ltd., Toronto 17, Ont.

Honeywell

First in Control

SINCE 1885

Growth is our pattern,
steel rolls our business The mold sweep held by Deac Scholl, Manager of Roll Sales, will help form the contours of another steel roll—one of the hundreds furnished by National in its rapid growth as a steel roll supplier. Their high quality, proved in service day after day, is responsible for the increasing number of mills turning to National for their steel roll requirements. Our sixty years experience in roll making is your assurance of our dependability and know-how. Talk with a National man about your next roll requirement—whether steel, iron or nodular iron. You'll find out why . . . NATIONAL'S THE GROWING NAME IN ROLLS.

NATIONAL ROLL & FOUNDRY DIVISION
GENERAL STEEL CASTINGS CORPORATION, Avonmore, Pennsylvania
General Steel Castings Corporation, General Offices: Granite City, Ill. Plants: Granite City, Ill., Eddystone, Pa., Avonmore, Pa.
Subsidiary: St. Louis Car Company, St. Louis, Mo.

Industry News...

J&L ADDS STATIONARY SINTER COOLER UNIT

△ A new sinter cooler—first of its type—has gone into operation at the New York Ore Division of Jones & Laughlin Steel Corp.

Installed on the division's sinter plant it differs from the conventional-type rotating cooler in that it is stationary, and the sinter is cooled by blasts of air as it works down through a vertical shaft.

Sinter is cooled in the new equipment for as long as 1½ hr as compared to 15 to 20 min in a circular cooler. Sinter from the new cooler can be loaded directly in railroad cars.

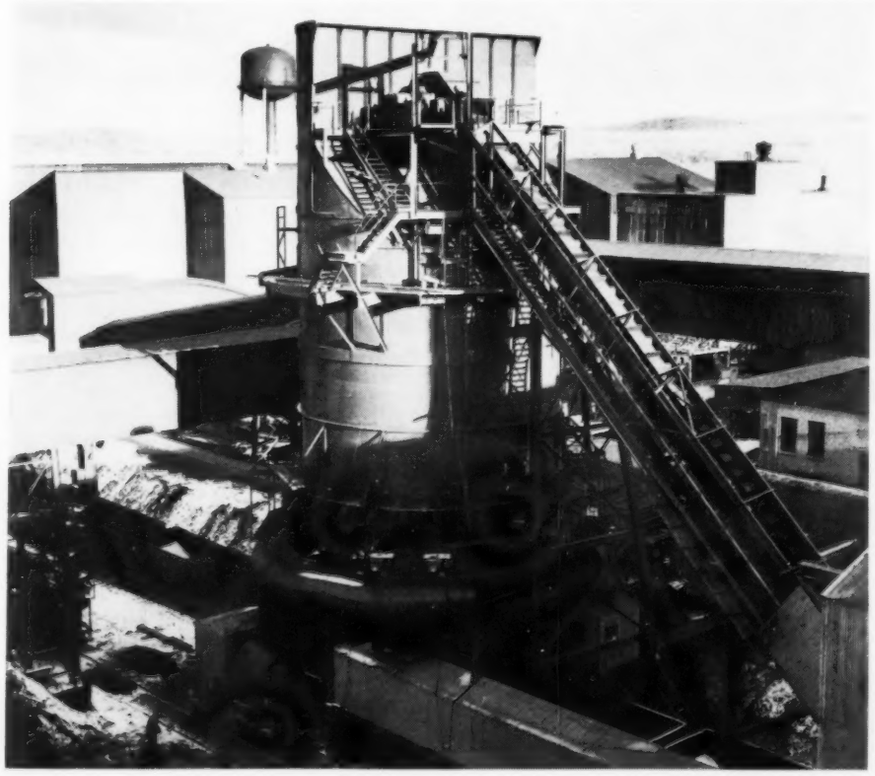
The cooler, which has a rated capacity of 3800 gross tons of product per day, was designed and installed by Dravo Corp.

The vertical shaft of the cooler is approximately 100 ft high, and has a diameter of 44 ft at its widest point. The installation also includes new breaking and screening facilities for the division's two six-foot-wide sinter machines.

In the operation of the new equipment, fused sinter leaves the two machines, and is discharged onto an apron feeder, which carries it to a new Dravo-Lurgi breaker. The material then passes through a new Dravo-Schenck vibrating screen which removes the hot fines or small particles. A pan conveyor then delivers the screened sinter to the cooler. At the discharge end of the cooler, a combination fender-screen removes the cold fines, and delivers the cooled sinter to railroad cars.

Most of the division's 1,000,000-ton annual rated output of magnetite ore, and its annual output of 740,000 gross tons of martite ore are sintered at the division's sinter plant before being shipped to J&L's steelmaking divisions.

Shown is the new sinter cooler operating at J&L's New York Ore Division. The new equipment differs from the conventional-type rotating cooler in that it is stationary, and sinter is cooled by blasts of air as it works down through the vertical shaft.



WHEELING DEVELOPS A LIGHT GAGE TIN PLATE

△ Wheeling Steel Corp. has announced the development of a new light gage high strength tin plate for the container industry. It will be made at the company's Yorkville Works.

Commercial production is expected to begin in March or April of this year, and will be manufactured in 55# and 60# base weights, in coils and sheeted plate.

W. A. Steele, Wheeling Steel president, emphasized that this is a special purpose product, "specifically designed to meet competition from other materials in the container field."

DONNER-HANNA AWARDS COKE OVEN CONTRACT

△ Koppers Co., Inc., has received a contract from Donner-Hanna Coke Corp. to construct a battery of 50 coke ovens and auxiliary equipment at its plant at Buffalo, N. Y. The contract also includes a new coal handling installation and new coal-chemical facilities.

The new battery of 13-ft high ovens with a carbonizing capacity of 1260 tons of coal per day replaces an existing battery of 51 ten-ft ovens with a capacity of 855 tons per day.

At present, the Donner-Hanna plant has a total of 252 coke ovens.

WHEELABRATOR FORMS NEW CANADIAN COMPANY

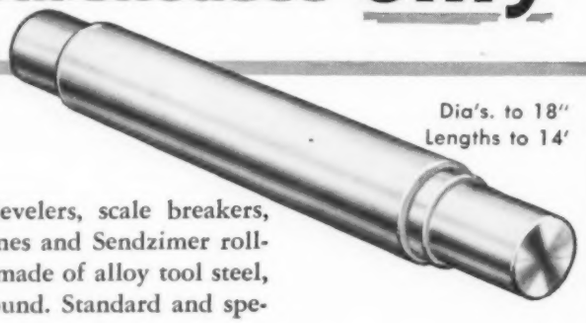
△ Formation of a new Canadian company, Wheelabrator Corp. of Canada, Ltd., has been announced.

The new corporation is the successor to the Canadian Division of Wheelabrator Corp. of Mishawaka, Ind., and was organized to handle expanding sales and fabricating activities for all provinces in Canada.

Wheelabrator supplies airless blast cleaning equipment, abrasives

For STEEL MILLS

and warehouses only



Dia's. to 18"
Lengths to 14'

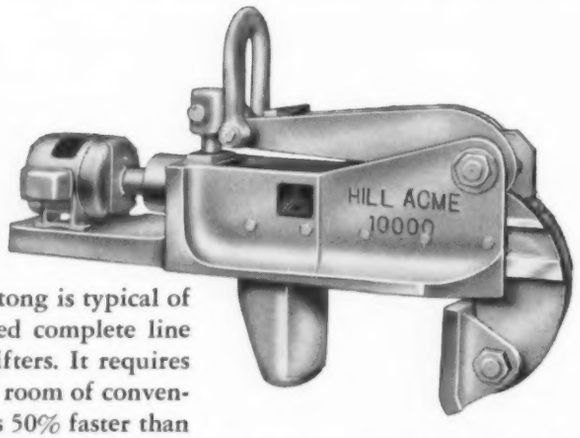
"HILL ACME" ROLLS

Custom made for levelers, scale breakers, straightening machines and Sendzimer rolling mills. Precision made of alloy tool steel, heat treated and ground. Standard and special types.

"CLEVELAND" METAL CUTTING KNIVES

The product of forty years of experience in manufacturing alloy grade, metal cutting knives of all types for shearing hot and cold metals.

"HILL ACME" MOTORIZED LIFTERS



This vertical coil tong is typical of the newly designed complete line of HILL ACME lifters. It requires only 1/3 the head room of conventional tongs and is 50% faster than mechanical types. Gives a constant grip ratio regardless of wall thickness and can be prepositioned to eliminate damage to the coil. Available up to 80,000 lbs. capacity. Contact us for "C" hooks, Rack Lifters, Billet, Sheet, Plate, Bar, Ingot and Ingot Mould Lifters.

THE HILL ACME COMPANY

HILL ACME MODERN TOOL INDUSTRY

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MANUFACTURERS OF: "HILL" Grinding and Polishing Machines • "ACME" Forging Machines • "CANTON" Rotary and Alligator Shears • BAR-BILLET Shears MATERIAL HANDLING Equipment • "CLEVELAND" Knives and Shear Blades.

and dust and fume collection systems from its plant in Scarborough, Ontario. It also has an office in Montreal, Quebec.

GE EXPANDING COMPUTER DEPARTMENT FACILITIES

△ Plans for a $4,000,000 addition to its manufacturing and headquarters facility at Phoenix, Ariz., were announced by General Electric Co.'s Computer Division.

The new expansion will add approximately 190,000 sq ft to the department's existing 204,000 sq ft manufacturing and administrative building.

Several weeks ago, the department announced plans for constructing a new $1,500,000 computer development and research laboratory at Sunnyvale, Calif., about 39 miles south of San Francisco. General Electric has been expanding its activity in the computer field and recently announced plans for opening 11 new information-processing centers across the nation and 10 new sales offices.

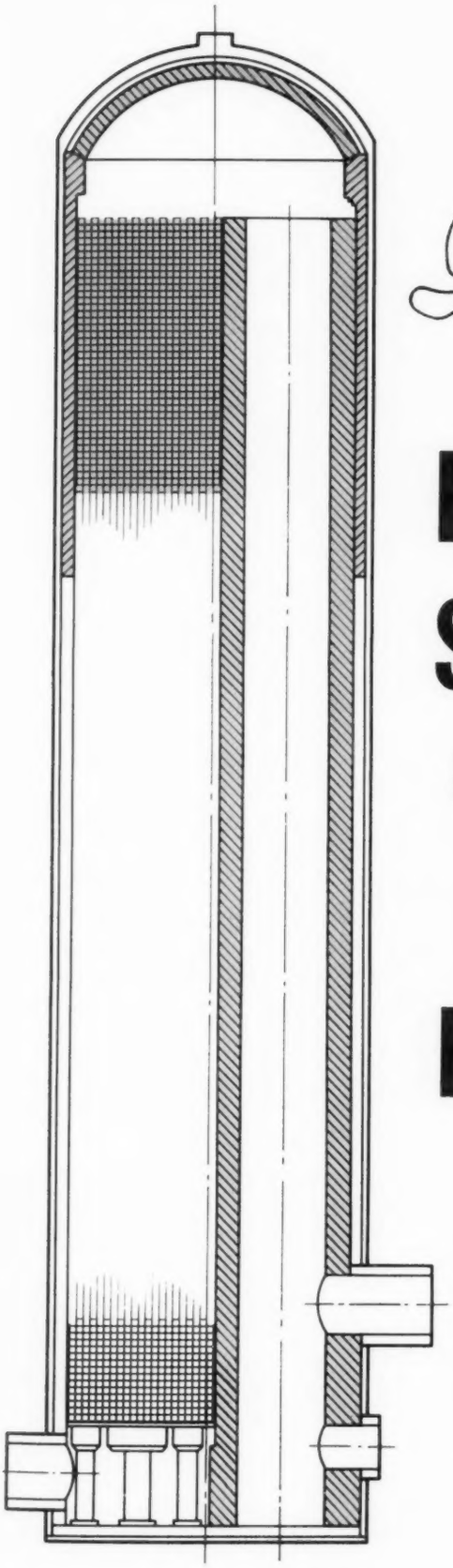
AWARD DRAVO CONTRACT FOR TWO UNLOADERS

△ Dravo Corp. has been awarded a contract by COSIDER S.p.A., of Genoa, consulting engineers for a combine of Italian steel firms, to design two unloaders each for Cornigliano S.p.A., of Genoa, and ILVA S.p.A., of Bagnoli, near Naples.

All four unloaders will be rope-operated, man trolley machines. Each will be equipped with a 17.5-metric-ton-bucket and will have a free-digging rate for iron ore of approximately 1550 metric tons per hour. Site characteristics will necessitate a number of differences between the machines designed for Genoa and those for Bagnoli.

Location of Cornigliano's wharf-type dock in a direct line with the main runway of the Genoa airport imposes unusual height limitations on the two unloaders there. They will be only 25.5 meters (83.6 ft) high and will be equipped with retractable aprons, rather than lift aprons, to provide the necessary clearance for ship superstructures without exceeding height limitation. The aprons will move in and out rather than being raised and lowered.

A turntable on the trolley will



A two-pass blast furnace stove with application of TAMUL brick and shapes shown in gray.

Increasing hot blast temperatures?

REINFORCE CRITICAL STOVE AREAS WITH TAMUL BRICK AND SHAPES!

Major blast furnace operators planning on increasing hot blast temperatures (to as high as 2000° F.) are now constructing stoves with dome, upper checkers, upper sidewalls, and combustion well walls of TAMUL (Taylor synthetic mullite) brick and shapes.

Excellent resistance to thermal spalling, alkali attack, and subsidence under long-term hot load, along with high refractoriness (P. C. E. — Cone 39) combine to make TAMUL the ideal refractory for these trouble spots. TAMUL should be laid up in new, improved TASIL cement.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Oakville, Ont., and Montreal

The CHAS. TAYLOR SONS Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REG. U.S. PAT. OFF.

REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U.S.A.

permit bucket rotation for more efficient digging under hatches, and the shuttle trolley reeving system will make possible quick bucket changes. The latter is an important feature, since the machines will unload coal as well as various grades of ore, thus requiring periodic switches to suitable buckets.

Both ore and coal will be unloaded through a hopper to a belt conveyor system on the dock, leading to storage yards, as well as directly to cars on the dock.

Hoisting speed of the two machines will be 435 fpm, with a trolley racking speed of 720 fpm. The unloaders will be designed to travel along the dock rails at a speed of 85 fpm.

Although similar to the Cornigliano unloaders in most respects, the ILVA unloaders must be designed to operate from a finger pier dock. The Bagnoli unloaders will be equipped with lift aprons and will unload through a hopper onto a belt conveyor leading to transfer belts and storage yards on shore and also to cars on the dock.

All four unloaders will be driven by adjustable-voltage d-c motors, operating from high voltage a-c power supplies. Rail clamps will prevent movement of the structure by high winds. These clamps automatically lock the structure to the rails when wind velocity reaches a pre-determined level, or in the event of power failure.

NEW VACUUM-MELTING FURNACE IN OPERATION

△ Ingots up to 50 in. in diam and weighing approximately 60,000 lb can be produced in the new vacuum-melting furnace now operating at the Watervliet Works of Allegheny Ludlum Steel Corp.

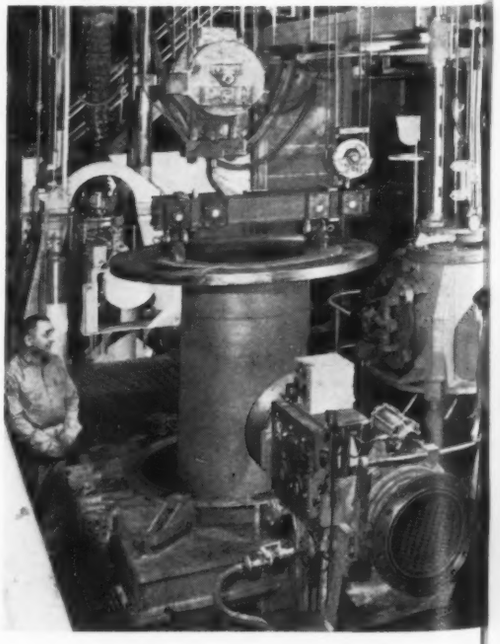
In its start-up phase, the furnace already has produced ingots of super-alloys and other high-alloy steels of 40-in. in diam.

The new furnace makes larger forgings and plates available to builders of aircraft, missiles, and rockets. It also is expected to lead to the expanded use of vacuum-melted materials in civilian markets.

The Lectromelt Division of McGraw-Edison Co. built the furnace at Watervliet Works. The new 50-in. furnace brings to 11 the number of consumable-electrode vacuum-melting furnaces in commercial production at Allegheny Ludlum.

Consumable-electrode furnaces

Workmen at Watervliet Works of Allegheny Ludlum observe the removal of a copper crucible from the new consumable-electrode vacuum-melting furnace.



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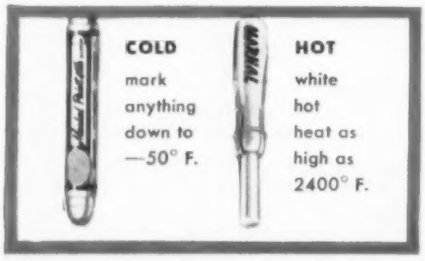
16 TYPES TO SERVE YOU.....

Markal Paintstik Markers are in constant use at the giant Kaiser Steel Corporation mill in Fontana, California. Markal "H-T," a red hot surface marker, is used in the plate mill for marking at temperatures up to 1800 °F. Markal "K," a white hot surface marker, is used on plates and ingots up to 2000 °F. and will withstand varied and extreme weather conditions.



COLD
mark anything down to —50° F.

HOT
white hot heat as high as 2400° F.

MARKAL... THE MARK OF QUALITY

Markal COMPANY
3087 West Carroll Avenue
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WRITE TODAY on company letterhead for catalog. Give details on marking problem for free sample.

We re-designed the motors' End Bells and early bearing failures stopped!

Here's another example of why it pays to work with our bearing engineers on every bearing problem.

Bearing failures were excessive on three h.p. gear reduction motors driving screw conveyors and elevators in a chemical plant. Our engineers determined that vibration, caused by light pressed steel End Bells, was responsible.

We re-designed the End Bells, had them cast in gray iron, and installed the proper anti-friction bearings which now give satisfactory service and life.

On all bearing problems large or small, be sure to call our branch nearest you. An experienced bearing engineer will be glad to help you.

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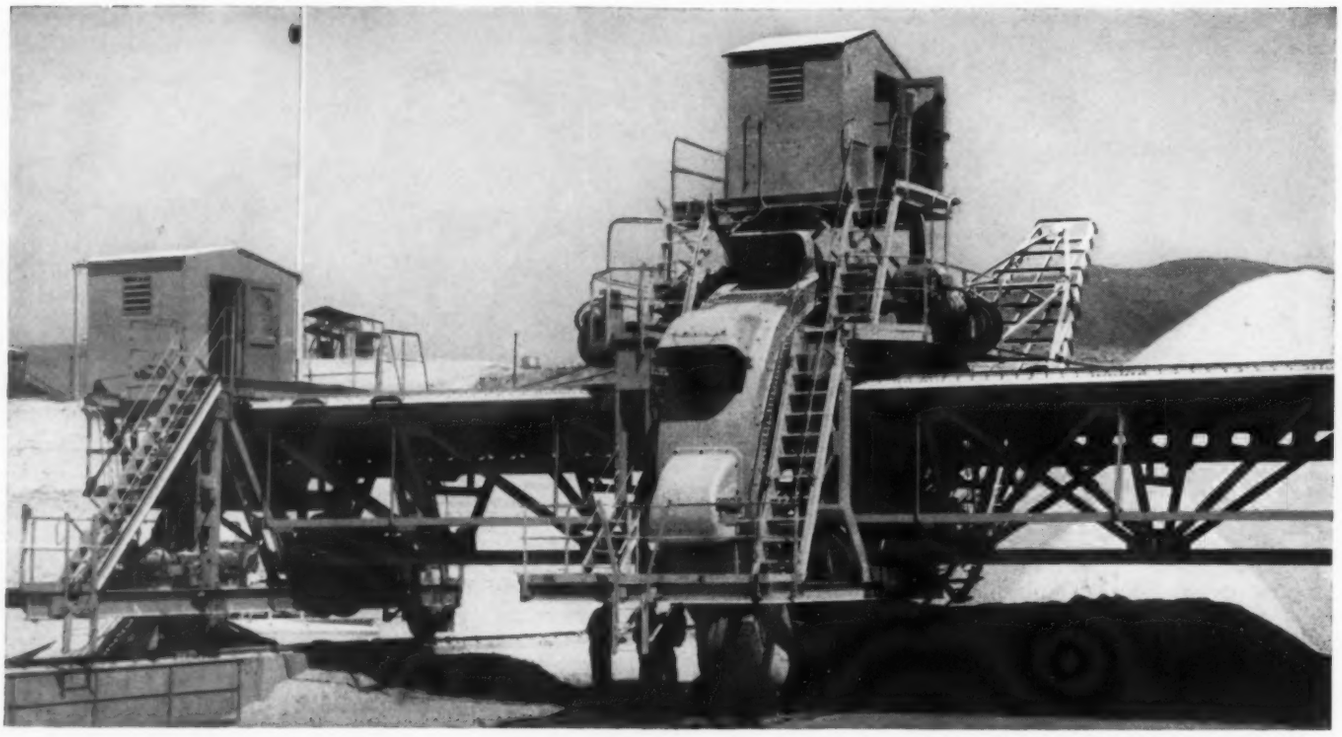


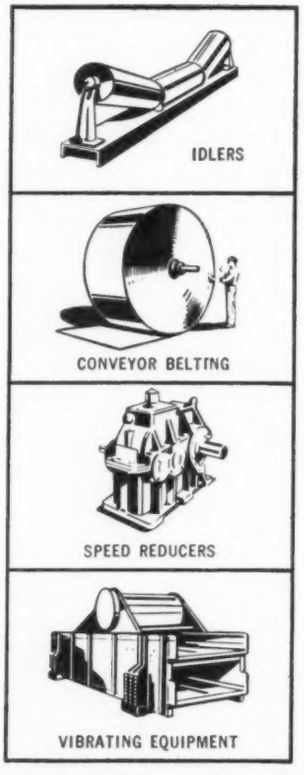
BIG WHEEL

It blends...it reclaims...it ends inefficiencies of selective mining

As part of a new H-R Rotary Bucket Wheel Blending and Reclaiming System, this giant 3-story wheel is capable of processing efficiently a broad range of materials . . . especially where more than one of the following typical situations exist:

1. Engaged in selective mining
2. Unable to comply with specifications
3. Too much coarse or fine material in feed
4. Storage pile requirements range 50,000 tons and over
5. Two or more types of raw material to blend for chemical compounding.

For full details consult your H-R representative, or write Hewitt-Robins, Stamford, Connecticut. Ask for Bulletin 2-50.



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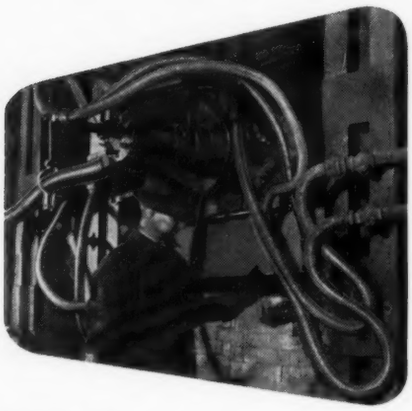
THAT STANDS HEAT ... ROUGH WEAR



PENFLEX FLEXIBLE TUBING FOR FUEL LINES... COOLING LINES... AIR LINES

Throughout steel mills from coast to coast they are relying on Penflex Tubing where the heat is high and the going tough.

Fuel lines and cooling lines on open hearth atomizers . . . oxygen and water lines on the lance in the oxygen process . . . air lines and diesel exhausts in the power plants . . . water feed lines on rolls . . . and in many other places Penflex is being specified. Penflex metal hose—corrugated and interlocked—absorbs any pipe movement due to extreme temperatures and pressures. Provides outstanding safety and uninterrupted flow of fuels, gases and volatiles. It is leakproof, tough and flexible. Write today for complete details of Penflex Tubing for the steel industry to...

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produce the high-alloy super-metals and close-specification low alloys that are required for supersonic aircraft, missiles, turbo-jet aircraft engines, atomic reactors and other important applications. Similar furnaces are also used in the production of titanium, zirconium and other metals which require controlled-atmospheres for high-purity melting.

The consumable-electrode vacuum-melting process consists of, first, casting cylindrical electrodes of a specified alloy composition from a conventional electric furnace; then remelting those electrodes under vacuum by means of an electric arc and recasting the metal in a water-cooled copper crucible. The vacuum serves the dual purpose of keeping contaminating elements out of the metal and of drawing off undesired gases from the electrode as the molten metal falls into the copper crucible during the melting process.

CF&I MODERNIZES 14-IN. PUEBLO ROLLING MILL

△ An extensive modernization of the Colorado Fuel and Iron Corp.'s 14-in. rolling mill at Pueblo, Colo., has been completed.

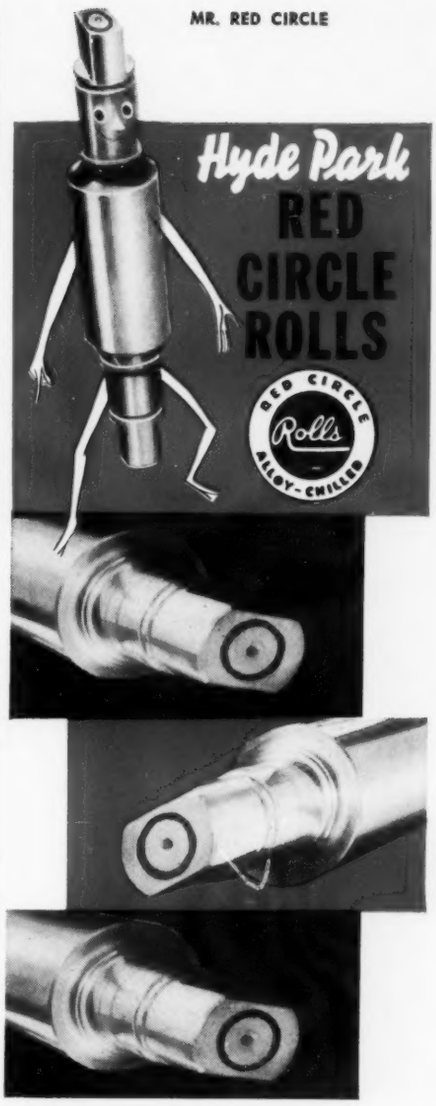
The improvements are part of the modernization program under way at the Pueblo, Oakland and South San Francisco plants.

The mill's finishing stand has been equipped with a new motor. The installation of pull-over "dogs," power roller lines, and electronic bar turners will improve transfer of bars between the mill's stands, while the utilization of spare housings, complete with installed rolls, will make for easier, faster section changings.

Meetings

△ The British Iron and Steel Institute's Annual General Meeting will be held in London, England, May 3 and 4. There will be technical sessions devoted to the use of computers in the iron and steel industry and to the Brymbo oxygen steelmaking process. At the same time, a joint symposium with The Institute of Metals on structural processes in creep will be held.

MR. RED CIRCLE



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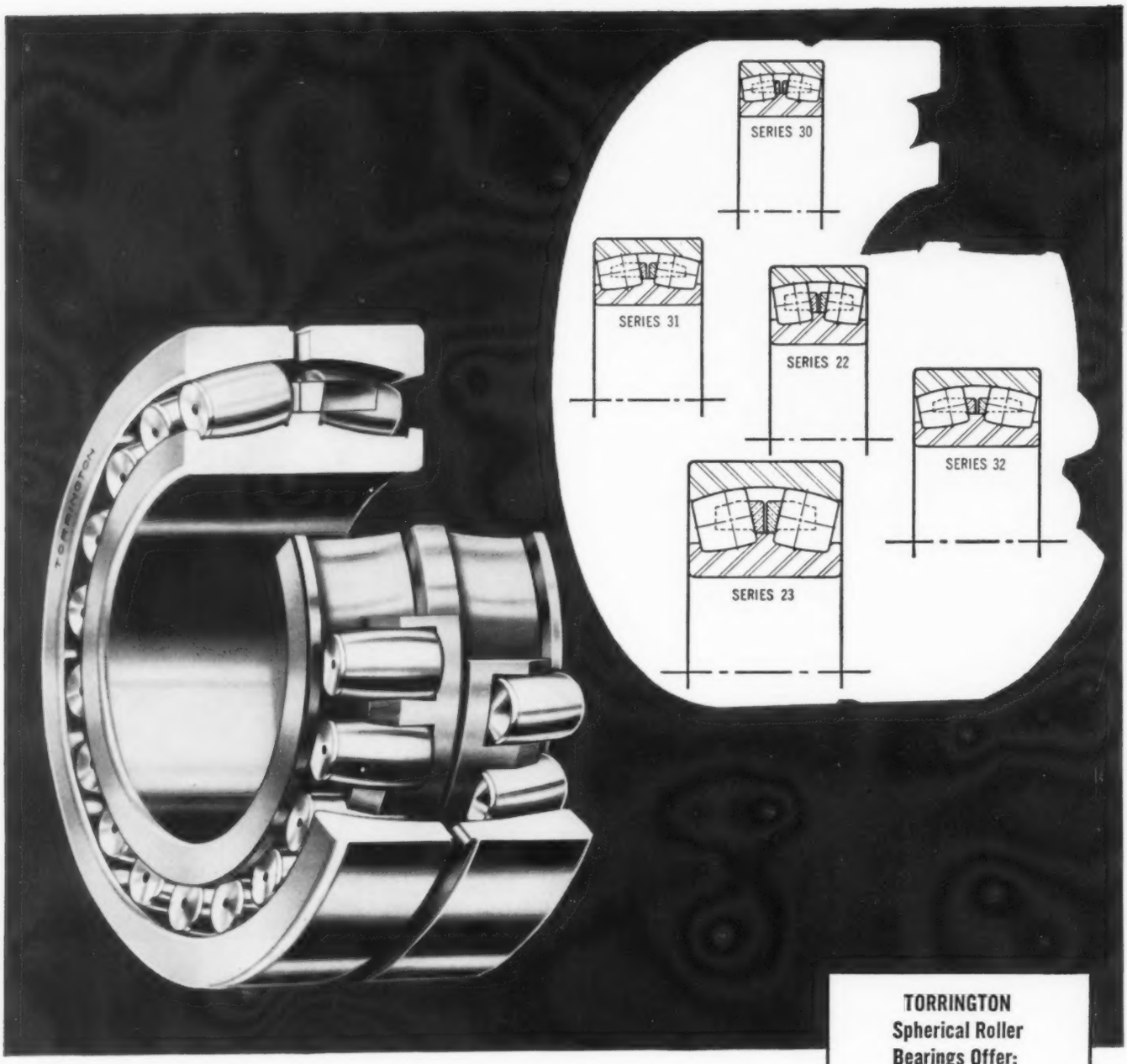

There's a Torrington Spherical Roller Bearing for your application

Bearings matched *exactly* to the job pay off in better performance, longer life, greater reliability. That's why it pays to specify carefully. And that's why it pays to choose Torrington Spherical Roller Bearings.

Whatever your space limitations or capacity requirements, the five series of Torrington Spherical Roller Bearings provide the right bearing for virtually every industrial application. You can design for straight bore or tapered bore with adapter. You can benefit from extra features such as lubrication groove and oil holes, or selected outside diameters.

Your use of Torrington Spherical Roller Bearings will assure exceptional operation and longer bearing life under the toughest conditions. They're made to Torrington's own uncompromising standards–the highest in the field of anti-friction engineering–by the manufacturer of every basic type of anti-friction bearing.

TORRINGTON Spherical Roller Bearings Offer:

- conformity of rollers to raceways
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- even load distribution
- long, dependable service life

Send for new Torrington Spherical Roller Bearing Catalog #258

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THE TORRINGTON COMPANY South Bend 21, Indiana • Torrington, Conn.

PUTTING IT ON THIS LINE PAYS OFF

- **IN LOWER PRODUCTION COST**
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Designing and installing a line like this involves a wide range of knowledge. This knowledge can be used to provide the answer to your particular furnace or heat treating requirements in equipment as large as this—or much, much smaller. Write or phone us. Drever Company, Bethayres, Pa. Phone WI 7-3400

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ENGINEERING AND MANUFACTURING FACILITIES AROUND THE WORLD THROUGH ASSOCIATES IN FRANCE, GREAT BRITAIN, GERMANY, ITALY, JAPAN AND INDIA

ONLY MIDVAC ROLLS OFFER ALL THREE... FOR LONGER LIFE...BETTER FINISHES

- VACUUM DEGASSED INGOTS
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Midvac Rolls offer qualities unsurpassed in cleanliness and ductility with superior uniformity of grain structure and maximum freedom from defects. The steels in Midvac Rolls far surpass any others now available and are the answer of M-H to the ultimate in roll perfection.

Vacuum degassing is just one of the many steps which safeguard the qualities of Midvac Rolls. Outstanding is the exclusive Midvac consumable electrode vacuum melting process which assures freedom from non-metallics . . . makes rolls last longer, produce a finer finish. Of the hundreds of Midvac Rolls now in service not one has ever broken and their deep Micro Lustre grain structure has permitted operators to repolish them in ½ the time of other rolls.

Improve product quality . . . get more footage out of every roll . . . specify Midvac Rolls for rolling stainless steel, foil and precious metals. Write today for details on these performance-proved Midvac Micro Lustre Rolls.

MIDVALE-HEPPENSTALL COMPANY
Nicetown, Philadelphia, Pa.
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Midvac Rolls

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(1) Materials Handling Handbook

The Automatic Transportation Co. has compiled a new 80 page "Handbook of Cost Cutting Materials Handling Ideas." This handbook contains: discussions of current materials handling problems—giving the pros and cons on such subjects as narrow versus wide aisles, walkies versus rider-type trucks, specials versus standard trucks, pallet versus palletless handling and how to select the right truck for the job; a thesis on how to analyze materials handling in your plant; flow charts; truck battery calculator charts for selecting the correct battery plus case histories of proven cost-cutting truck applications.

(2) Welding Electrodes

A new eight-page folder containing case history reports on the successful use of welding electrodes in three varied industries is available from the McKay Co. One report outlines how McKay engineers developed a special welding electrode to help solve a costly nuclear Ramjet problem for a supplier working on Project Pluto, the highly classified government space program. Another case history shows how a major steel producer extended the service life of blooming mill guides 900 per cent through hard surfacing. The third report takes the reader into the plant of a west coast pump weldment fabricator to see how this firm gets consistently high quality welds by using stainless steel electrodes. (Insert Bulletin A-3)

(3) Plant Safety System Bulletin

The new plant safety system developed by the North American Mfg. Co. for plants using gas, is described in a newly-released bulletin. Acting as mainsprings of this system are safety shutoff valves and supervising gas cocks, which afford two-way plant protection. First, in case of a fire, fuel that might otherwise be fed into the fire giving it a "shot in the arm" can be completely cut off immediately. Secondly, in a plant that does not operate continuously, the foreman needs only to push one button and the safety shutoff valve stops all fuel flow until the next crew is ready to start operations again. The supervising cock system then takes over by further assuring no "lighting-off" explosions, since all gas cocks must be closed before the safety shutoff valve can be opened. This bulletin also describes how this safety system would work in a plant using fuel oil. (Supplemental Bulletin 22)

(4) Industrial Brakes—Crane Hand Signal Decals

Two bulletins on industrial brakes and a crane hand signal decal are being offered by Ederer Engineering Co. Bulletin CE-410 covers d-c series 600 industrial brakes and bulletin CE-420 covers a-c series 200 industrial brakes, both for general industry use. The crane hand signal chart decal, $7\frac{1}{4}$ x $9\frac{3}{4}$ in., is designed for installation in crane cabs for ready reference. (Bulletins CE-410 and CE-420)

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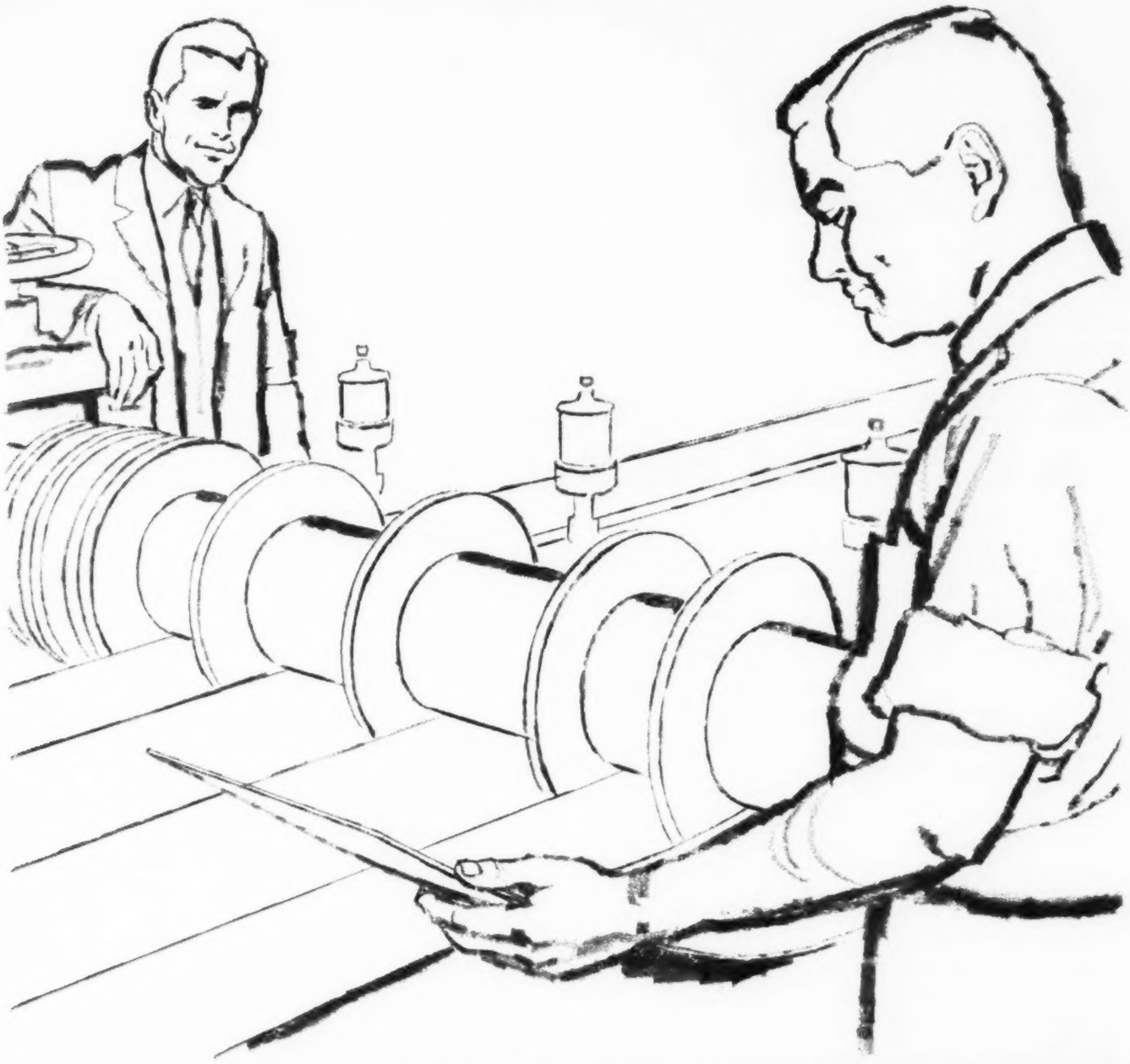


Can you get longer edge life from your SLITTER KNIVES?

A·S·K for the answer!

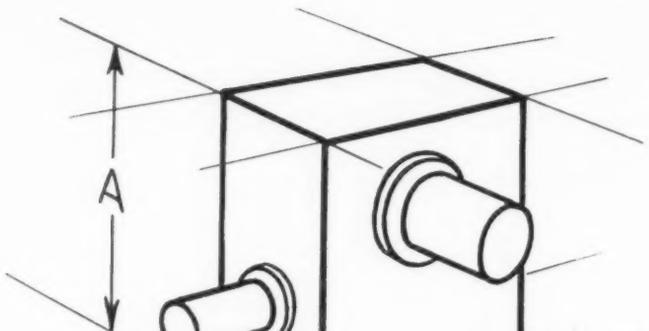
AMERICAN SHEAR KNIFE

The answer is yes when you use slitter knives from A.S.K. (American Shear Knife Company). A.S.K. Slitter Knives last longer, stand up better under the heaviest jobs, reduce maintenance and replacement costs!

Why? Because A.S.K. has devoted years of research to the selection of proper alloys, and correct techniques in heat treating, precision grinding. For slitter knives that last longer, improve your slitting operation . . . Ask A.S.K.!

FREE HANDBOOK—Want a handy reference on the installation, operation and maintenance of slitter, shear and chipper knives? A.S.K. has the answers in an 88-page manual. For free copy, write American Shear Knife Co., Homestead, Pa.

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

Personnel News...

Charles M. White has retired as chairman of the board and chief executive officer of Republic Steel Corp. He has been succeeded as chief executive officer of the company by **Thomas F. Patton,** who will continue as president. The position of chairman of the board has been abolished. Mr. White will continue as a director of the company, and has been designated honorary chairman of the board. Mr. White's retirement climaxes a career in the steel industry spanning nearly half a century. During the past 30 years he has served Republic in various top executive positions and has been chief executive officer of the company since 1955. Mr. Patton has been president since 1956 and served three years as assistant president and first vice president prior to his election as president of the company.

William D. Spaulding has been named vice president —operations of Weirton Steel Co., Division of National Steel Corp. Mr. Spaulding succeeds **Charles E. Carr** who has retired. Mr. Spaulding joined Weirton in 1924 after working with the Carnegie Steel Co. at Mingo Junction, Ohio. After two years as a test engineer in the coke plant at Weirton, he became a heater, then was named a boss heater in 1928. In 1930, he became by-products general foreman, was named superintendent of the coke plant in 1940, was promoted to superintendent of blast furnaces and coke plant in 1953 and was named manager of the steel works in 1954. Mr. Spaulding was appointed vice president—operations of Great Lakes Steel Corp., in 1955. Two years later he was promoted to the National Steel Corp.'s Engineering Department in a technical capacity. In 1958, he was advanced to the National Steel Research Department where he was named in charge of general research problems in coal, coke, steel practices, water and air pollution, holding that position until his current appointment. Mr. Carr joined Weirton from The Youngstown Sheet and Tube Co. in 1921. His first job was as second helper in the Open Hearth Department. In 1922, he was named first helper in the open hearth, became assistant superintendent in 1927 and superintendent in 1940. In 1943, Mr. Carr was named assistant manager of the steel works, was named steel works manager in 1952 and in 1954 was promoted to general superintendent of the company. In 1955, he was advanced to vice president—operations.

W. E. Gregg, formerly vice president—technology with Crucible Steel Co. of America, has been appointed vice president—operations. He succeeds **J. D. Dickerson** who has been assigned new administrative responsibilities with Crucible. At the same time **E. A. March,** formerly director of metallurgy and technical development, was named director of technology and will be responsible for the direction of the Technology Department.

Sidney A. Shuman has been elected vice president and general manager, National Supply Division, Armco Steel Corp., succeeding **A. W. McKinney,** who has retired. Mr. Shuman has been active in the oil and oil supply industries since 1925. In 1936, he joined the Fluid Packed Pump Division of National Supply, and in 1960 he became assistant to Mr. McKinney.

Paul W. Coffman has been named general superintendent of Acme Steel Co.'s Riverdale, Ill., plant. Mr. Coffman joined Acme in 1950 as assistant superintendent of the Cold Mill Division, became superintendent of the division in 1955 and in 1958 was named assistant general superintendent of the Riverdale plant.

John C. Siadak has been appointed assistant superintendent of No. 2 tin mill at the Youngstown Sheet and Tube Co.'s Indiana Harbor Works. Mr. Siadak will share operational responsibilities with **Rudolph F. Spacek, Jr.**, who was promoted to assistant superintendent about a year ago. Mr. Siadak will be in charge of tin plate coating, finishing, shearing and recoiling. Mr. Spacek will supervise cold reduction, cleaning and annealing.

Morton J. Reynolds has been appointed superintendent of the Colorado Fuel and Iron Corp.'s South San Francisco, Calif., plant. Mr. Reynolds succeeds

T. F. PATTON

W. D. SPAULDING

W. E. GREGG

S. A. SHUMAN

W. L. KEENE

C. C. HILTON

J. H. ZIEGLER

W. F. KAST

Louis F. Bonofiglio who will head the Oakland plant operations. Mr. Reynolds has been assistant superintendent for the Pueblo plant's wire mills since 1950. He was made assistant superintendent at South San Francisco in 1949 and prior to this had been general foreman.

Walter L. Keene has been named general manager of operations, Superior Steel Division of Copperweld Steel Co. He succeeds **J. W. Marrinan,** who has retired after 45 years of steel industry service. Mr. Keene has been director of research and metallurgy for Superior Steel since 1945. Mr. Marrinan has been active in steel industry management since 1927 when he was named assistant to the president of A. M. Byers Co. He served as vice president—operations of A. M. Byers for 24 years, joining Superior Steel in 1954.

Charles C. Hilton has been appointed superintendent—primary mills at the Ecorse, Mich., main plant of Great Lakes Steel Corp., a division of National Steel Corp. Mr. Hilton, formerly assistant superintendent—primary mills, succeeds **R. B. Allard**, who has retired. Mr. Hilton began his career with Great Lakes in 1959. Previously, he was an assistant superintendent at Bethlehem Steel Co.

J. H. Ziegler was named superintendent of the Sheet and Tin Department at Republic Steel Corp.'s Warren, Ohio, plant. He served as general foreman of the district's terne line since 1957. He also was a foreman in the Galvanizing Department for two years and foreman of the district's tin mill in Niles, Ohio, from 1937 to 1955.

William F. Kast was named chief engineer, Loftus Engineering Corp. He was formerly a fuel and combustion engineer with U. S. Steel Corp.

Robert V. Cordingley, formerly assistant general superintendent of the Youngstown Sheet & Tube Co.'s Indiana Harbor Works Strip, Sheet and Tin Mills Division, was promoted to general superintendent, steel plant, rolling and finishing. **John C. Cannon,** who was superintendent of No. 2 tin mill, succeeds Mr. Cordingley as assistant general superintendent, Strip, Sheet and Tin Division. **Howard C. Rodgers,** who was superintendent of No. 1 tin mill finishing, becomes superintendent of No. 1 tin mill and **Norman W. Tucker,** formerly superintendent of No. 1 tin mill cold reduction, succeeds Mr. Cannon as superintendent of No. 2 tin mill.

J. W. Cunningham has been appointed manager of Air Reduction Sales Co.'s district sales office in Pittsburgh, Pa. Mr. Cunningham has been associated with Airco since 1947. He first served as a research engineer at Airco's research laboratories and subsequently became a field development engineer in 1951. Three years later he was appointed product sales manager for gas-shielded arc welding products and processes in the equipment marketing department in New York. Mr. Cunningham was appointed assistant manager of Airco's Equipment Marketing Department in 1959, a position he has held until his present promotion.

Robert A. Bechtold has been appointed assistant superintendent of open hearth and electric furnaces at the Gadsden, Ala., plant of Republic Steel Corp. He has been transferred from Massillon, Ohio, where he was assistant superintendent of the Open Hearth Department.

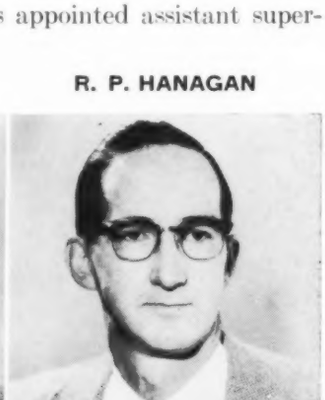
Leo D. Dunlap was named general superintendent, Edgewater Steel Co. Formerly superintendent of manufacturing, he assumes some of the responsibilities previously held by **R. M. Heyl**, who reached retirement age December 31.

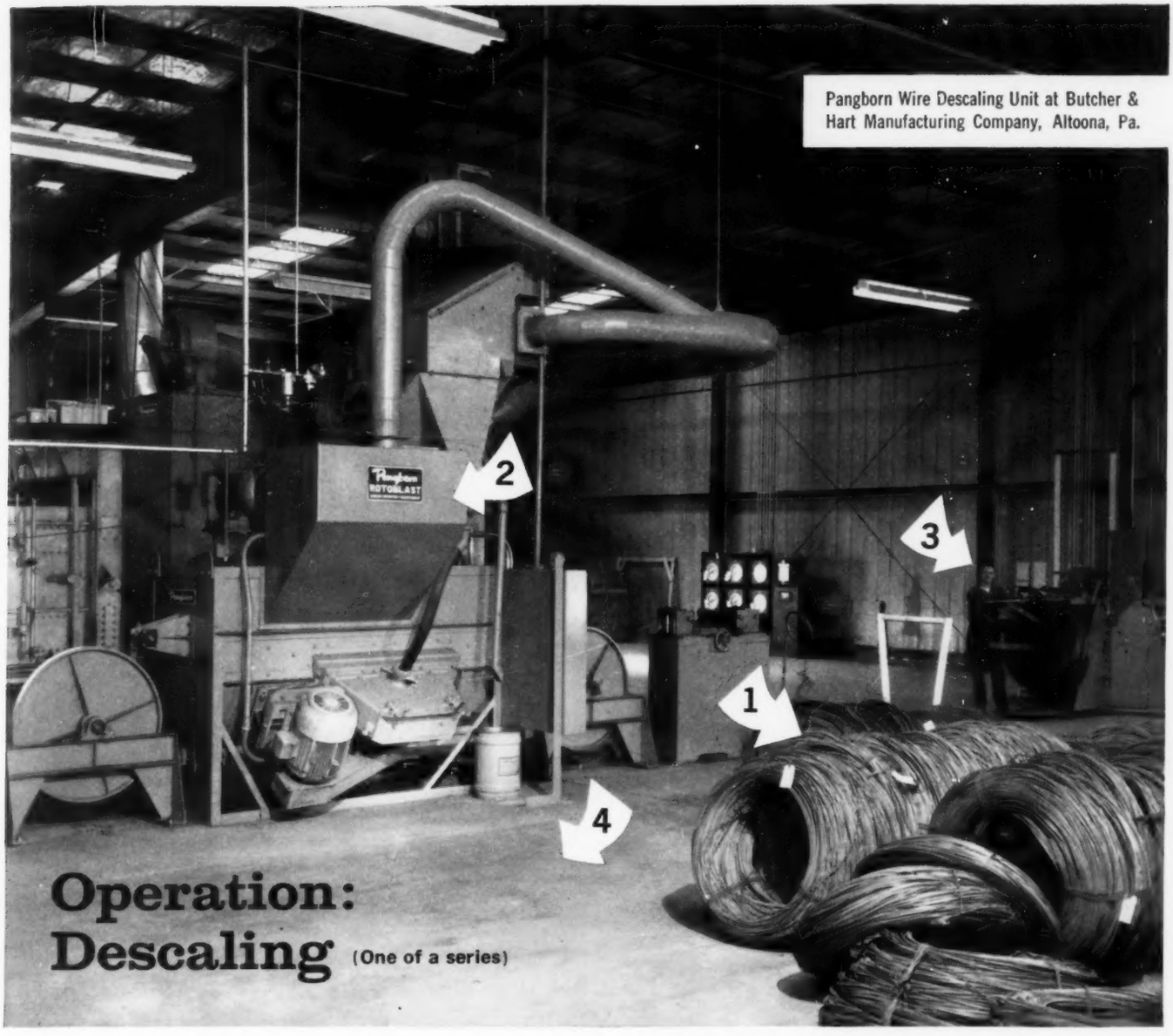
Leo C. Hilt has been appointed assistant superintendent of The Colorado Fuel and Iron Corp.'s seamless tube mill at Pueblo, Colo. Mr. Hilt has been assistant superintendent of the seamless tube mill's hot mill since 1956. He joined CF&I in 1953 as general foreman there. Prior to joining CF&I he was associated with National Tube in Gary, Ind., working as a seamless tube mill turn foreman.

Robert P. Hanagan was appointed assistant super-

L. C. HILT

R. P. HANAGAN





Q: Does Rotoblast end acid disposal problems?
A: Yes, and it cuts costs in the process.

1. Rotoblast eliminates loss of virgin metal

When wire and rod descaling is done through pickling, some virgin metal is invariably lost. Operating experience shows that there is no loss of virgin metal with Rotoblast Descaling. Also, there isn't any acid requiring disposal. Problems like water pollution are made obsolete in many areas of operation by Rotoblast.

2. Rotoblast reduces investments

With Rotoblast, savings on wire and rod descaling equipment can run as high as 70% on the original investment when compared with the investment required for pickling equipment.

3. Rotoblast minimizes descaling time

Wire and rod descaling goes faster with Pangborn Rotoblast than with pickling. Also, Rotoblast requires less manpower. Either way—or both—it cuts labor costs. (Following a patenting furnace, Rotoblast can descale multiple strands of wire, 40 or more at a time.)

4. Rotoblast frees space

Since Rotoblast requires only ¼ to ⅓ as much space as pickling equipment, it frees the difference in floor space for other operations. Also, this airless-blast machine can be easily installed in line with coating and drawing equipment to provide straight-through production. Rotoblast-cleaned surfaces are ideal for any type of coating or for drawing compounds.

You, too, can effect considerable savings with the Rotoblast Descaling Unit in your wire and rod descaling operations. Talk with your Pangborn representative or write: PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Maryland. *Manufacturers of Blast Cleaning, Vibratory, Dust Control Equipment—Rotoblast® Steel Shot and Grit©.*

Pangborn
OF HAGERSTOWN

intendent of Pueblo's wire mills. He has been general foreman of the wire mills since 1954.

Kenneth N. Bundy was named superintendent of the Utilities Department, at Wheeling Steel Corp.'s Steubenville Works. He has been with Wheeling Steel since 1941 and, prior to this promotion, was assistant superintendent of the Steubenville Works Coke Plant Department. **Harry H. Phillips, Jr.,** succeeds Mr. Bundy in that capacity. Mr. Phillips joined Wheeling in 1959 as technical assistant to the division superintendent, Services Division, Steubenville Works. Before that, he was with Jones and Laughlin Steel Corp. and United States Steel Corp.

E. F. Andrews was elected vice president in charge of purchases of Allegheny Ludlum Steel Corp., succeeding **Lester H. Bittner** who retired December 31. Mr. Andrews joined Allegheny Ludlum as assistant to the vice president in charge of purchases in 1958 and was named director of purchases in 1959.

Thomas A. Kenny was named instrumentation consultant for Curtiss-Wright Corp., handling the application and sale of recorders and associated electronic products in the Greater New York area. He had previously served with Westinghouse, Western Electric, Westchester Light and Power, West Penn Power and Weston Instrument Co., prior to becoming district representative for Esterline-Angus in 1939, covering the Pittsburgh territory. Since 1947, he has served as product representative for Esterline-Angus in the New York area.

N. J. VANG

D. W. SHOEMAKER

Norman J. Vang was elected vice president of manufacturing for Corhart Refractories Co. At the same time **Donald W. Shoemaker** was appointed manager of manufacturing services for the company. Mr. Vang has most recently served as assistant to the staff vice president of Corning Glass Works, parent company of Corhart Refractories. Mr. Shoemaker has been manager of manufacturing for Corhart since 1957.

Gail B. Hamilton, Jr., has been appointed manager of a new process automation sales operation at General Electric Co.'s Industry Control Department. In his new position, Mr. Hamilton will be responsible for the application and marketing of electrical and electronic controls used in automation of industrial process lines. He joined General Electric in the Schenectady test program in 1949 and was transferred shortly to the

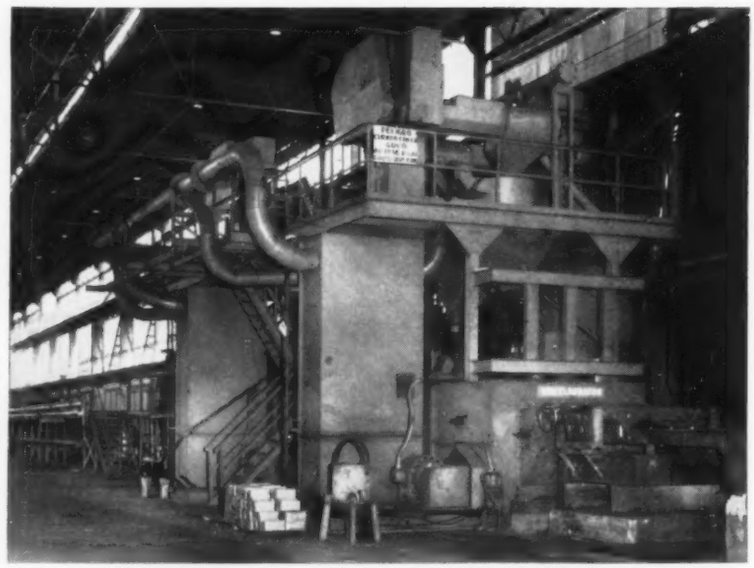
EXECUTIVE REPORT #11

HERE CARBON STEEL SHEDS ITS SCALE

Wheelabrator® Descaling Enables 100% Increase in Production

Every ton of steel produced in the modern mill of Altos-Hornos De Mexico, S.A., at Monclova, Coahila, is run through a Wheelabrator airless blast descaling cabinet. In a typical month, over 15,500 tons of carbon steel from a hot Steckle reversing type mill was Wheelabrator descaled followed by a light pickle rinse. The end product is reduced on reversing cold mills for sale as cold rolled steel, tin plate, and galvanized stock.

Steel is descaled in this new line at a rate of up to 200 f.p.m. contrasted to a speed of only 100 f.p.m. when acid pickling was used exclusively for descaling. Even with this increase in production, acid consumption has been cut in half and overall descaling costs materially reduced.



Wheelabrator Engineering Experience At Your Service

Write today for information on how Wheelabrator descaling can cut your costs and speed production. Wheelabrator Corporation, 396 S. Byrkit St., Mishawaka, Indiana. In Canada, P.O. Box 490, Scarborough, Ontario.

WHEELABRATOR
AIRLESS BLAST EQUIPMENT

Industrial Division concentrating on steel mill sales. In 1953, he was transferred to the apparatus sales office in Indianapolis, Ind., as a sales engineer. Two years later he was sent to the Industrial Heating Department, as an application engineer. In 1959, he was named manager, marketing development and research for industrial heating.

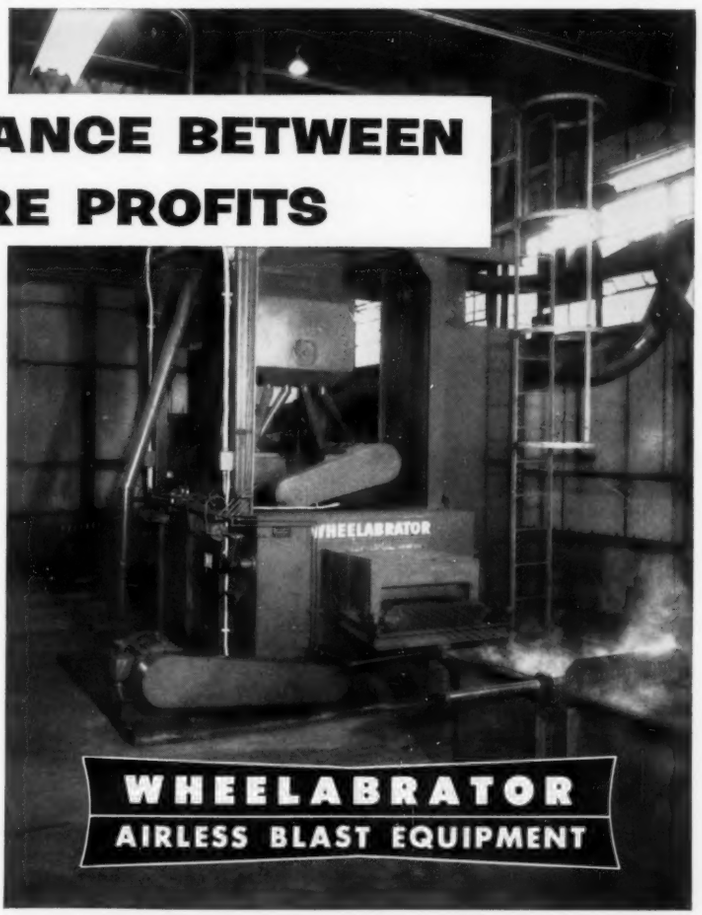
C. L. Frost has been appointed manager of distributor sales of Hewitt-Robins, Inc. Mr. Frost was formerly a regional sales manager and before that he was the advertising manager. In the past year he has specialized in the promotion of sales of Hewitt-Robins rubber products to the petroleum industry.

W. F. Lent, Cutler-Hammer vice president, retired December 31. He had been with the company 42 years, starting as an application engineer. Later he served as manager of the firm's Molding Department and as production manager. He became works manager in 1950 and vice president in charge of manufacturing in 1956. He relinquished this post in 1959 but continued as a vice president.

Ben T. Beasley has been appointed superintendent of the Electrical Department of Republic Steel Corp.'s Cleveland District steel plant. Formerly assistant superintendent of the Electrical Department, he succeeds **I. N. Tull,** who will devote his entire time to the duties of chairman of the corporation's Electrical Committee. **Walter C. Miller** succeeds Mr. Beasley as assistant superintendent of the Electrical Department. Mr. Beasley has held the position of assistant superintendent of the Electrical Department (steel plant) in the Cleveland District since joining Republic in 1949. Prior to that time he held the position of quarterman in the Public Works Department of the U. S. Naval Ordnance District in So. Charleston, W. Va. He has also served as assistant superintendent of maintenance for the Carnegie-Illinois Steel plant in So. Charleston, W. Va., and as maintenance electrician for the American Rolling Mill Co. in Ashland, Ky. Mr. Tull held positions with the Carolina Telephone and Telegraph Co. and the General Electric Co. prior to joining the old Corrigan-McKinney Steel Co. plant in Cleveland in 1915 as an electrical engineer. In 1927, he was placed in charge of all electrical maintenance at the plant. When Corrigan-McKinney merged with Republic in 1935 he was named electrical superintendent, and since 1939 has also served as chairman of the corporation's Electrical Committee. Mr. Tull is past president and a life member of the AISE.

Leopold DeFiore, director of engineering for the Youngstown Sheet and Tube Co., has retired after 50 years in the steel industry. He began his career in the Engineering Department of the Carnegie Steel Co. in New Castle, Pa., moved on to Babcock & Wilcox Co., and then to Dominion Foundry and Steel Ltd. in Hamilton, Ontario. In 1917, he became a draftsman at Youngstown Sheet and Tube, and later was active in the company's expansion, taking direct charge of rebuilding, modifying, and expanding mills at Campbell, Brier Hill and Indiana Harbor. In 1935, Mr. DeFiore became division engineer at the Brier Hill plant and held that post for nine years. He left then to become

EXECUTIVE REPORT #25



THE SHORTEST DISTANCE BETWEEN STEEL ROD AND WIRE PROFITS

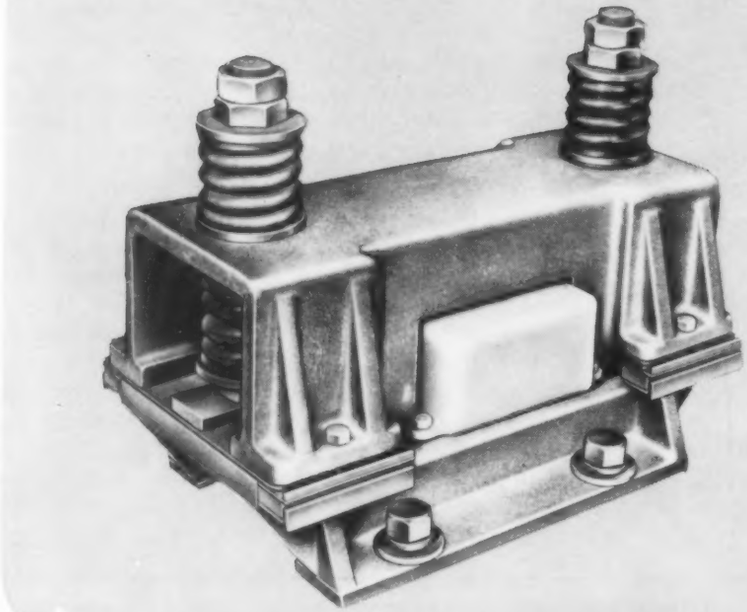
Wheelabrator® Straight-Line Cleaning, Patenting, Coating

At Leschen Wire Rope Division of H. K. Porter Co., Inc., 12 strands of hot-rolled rod go simultaneously through patenting, cleaning and coating in one continuous operation. Wheelabrator mechanical blast descaling is the essential step that makes this efficient processing possible. The blast descaling process eliminates the problems associated with acid pickling, and makes additional savings in time and labor costs.

This efficient production line operates continuously for 24 hours a day, 5 days a week without down time. Investigate the benefits you can realize with this new process for cleaning any type of ferrous or non-ferrous hot rolled rod and bar stock for cold drawn products. Write to **Wheelabrator Corp., 396 S. Byrkit St., Mishawaka, Ind. In Canada, P. O. Box 490, Scarborough, Ont.**

KEEP BULK MATERIALS FLOWING FREELY

SYNTRON ELECTRIC VIBRATORS



ASSURE STEADY MATERIALS FLOW FROM BINS, HOPPERS, CHUTES

Syntron builds an Electromagnetic Bin Vibrator unit to meet almost every requirement. Prevents most types of bulk materials from arching or plugging in bins, hoppers, and chutes.

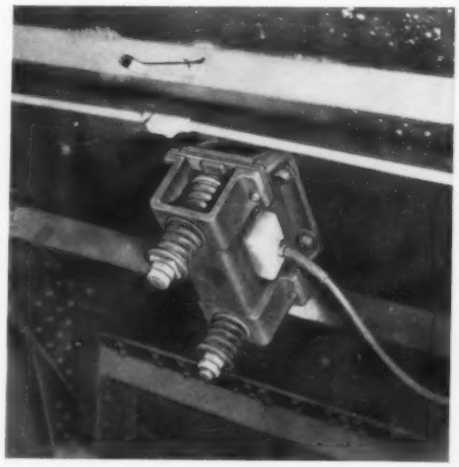
The Electromagnetic drive unit produces 3600 instantly controllable vibrations per minute, providing a steady materials flow to processing equipment.

Every Syntron Electromagnetic Bin Vibrator is rugged and durable. The absence of mechanical moving parts assures long, trouble-free service with very little maintenance.

Keep bulk materials flowing efficiently and economically.

Write for a Syntron Catalog and the name of the representative nearest you.

Write for a Syntron Catalog and the name of the representative nearest you.



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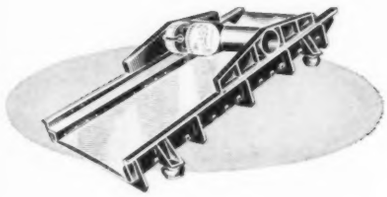
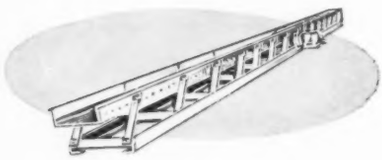
Other SYNTRON *equipment of proven dependable quality*



Vibrating Screens

Roll Neck Seals

Rectifier Power Units



Mechanical Vibrating Conveyors

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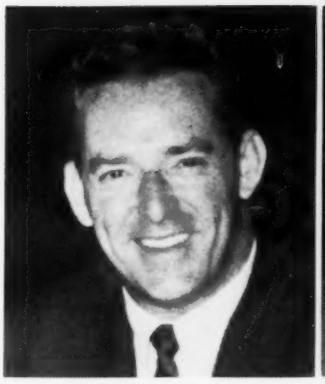
chief engineer at South Chester Tube Co., Chester, Pa., and a year later joined Morgan Engineering Co. as assistant chief engineer in charge of mill equipment. Late in 1946, he went to Portsmouth Steel Corp. as chief engineer. Mr. DeFiore returned to Sheet and Tube in 1956 to head the company's active building program.

I. L. Case has been appointed vice president in charge of the Pittsburgh district and **Richard T. Horsfall,** vice president in charge of engineering for the W. W. Clark Corp. Mr. Case has been an associate of the firm since 1946, and a member of the Pittsburgh office since 1950. Prior to that he was with the Weirton Steel Co. Mr. Horsfall was formerly chief engineer.

Karl Koehn has been elected to the position of vice president of the Pittsburgh District, Hunter Construction Co. Mr. Koehn started working in the Rolling Mill Division of Demag Co. in Duisburg, Germany, in 1917. He came to the United States in 1922 and worked for Mesta Machine Co. as a field representative. From 1950–1953 Mr. Koehn worked with Pittsburgh Engineering as superintendent of erection. From 1953–1959 he was with Commercial Contracting Corp. as assistant vice president. Mr. Koehn started with Hunter Construction in 1959.

Robert F. Cox has joined Pangborn Corp. as a sales engineer. Formerly with Cummings Engine Co., Inc., Columbus, Ind., he will be assigned to Pangborn's Hagerstown and Baltimore districts.



GEORGE ANDREWS

W. S. MC ALEER

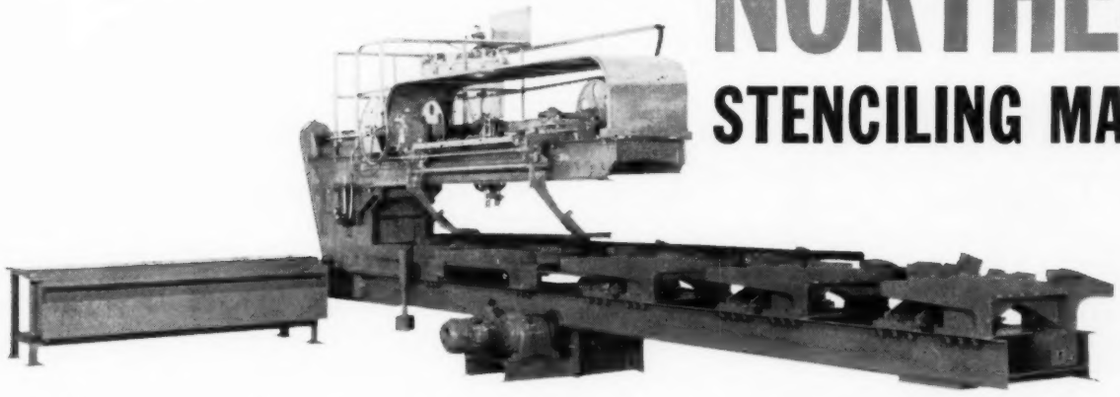
George Andrews was appointed head of Refractory & Insulation Corp.'s new sales office and warehouse in Pittsburgh, Pa. Mr. Andrews was formerly with Banks-Morton Co.

William S. McAleer has been elected vice president and a member of the board of directors of Peter F. Loftus Corp. Mr. McAleer formerly was vice president of McNally Pittsburg Mfg. Corp.

Oscar L. Dunn has been elected a vice president of the General Electric Co. Mr. Dunn is general manager of the company's Motor and Generator Division, with headquarters in Erie, Pa. He began his career with General Electric in 1936 in Bridgeport, Conn. Following graduation from the company's business training course,

NORTHEAST

STENCILING MACHINES



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Write for Bulletin No. 360 for complete description, operative details and specifications.

Northeast Stenciling Machines take their natural place in the modern production line to eliminate laborious hand operations and reduce production costs by maintaining a synchronized pace with the operation sequence of component equipment.

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he held a series of assignments in consumer products departments. From 1951 until mid-1953, Mr. Dunn was administrative assistant to the executive vice president of General Electric's apparatus group. Then he was named general manager of the Direct Current Motor and Generator Department, a position he held until his appointment as general manager of the Motor and Generator Division in 1958.

William F. Rehn has been named assistant superintendent of The Youngstown Sheet and Tube Co.'s cold strip mill at the Campbell Works. He joined the company in 1948 as an assistant metallurgist. He was promoted to strip mill metallurgist in 1955.

Edwin J. Bernard was appointed manager of the Non-Ferrous Division, Amsler Morton Co. He first directed furnace design and engineering at the New Kensington, Pa., Works of Aluminum Co. of America for eight years until 1948, and then was chief furnace engineer for Reynolds Metals Co., in Richmond, Va., until 1959. More recently he was in the non-ferrous furnace division of Loftus Engineering Co.

Walter B. Baisch, vice president in charge of operations of Michigan Seamless Tube Co. since 1950, has been elected to the position of vice president and general manager.

Eugene A. Gietzen has been appointed chief metallurgist of Bethlehem Steel Co.'s Lackawanna, N. Y., plant. He succeeds **Herbert J. Cutler**, who has retired. Mr. Gietzen served as a metallurgist for Donner Steel Co. before joining the Metallurgical Department of the Lackawanna plant as a metallographist in 1929. He was appointed assistant chief metallurgist in 1950.

Leon Lipson has been named assistant superintendent of the Mechanical Department of Republic Steel Corp.'s Youngstown, Ohio, plant. Mr. Lipson joined Republic in Youngstown in 1948 as a technical operating trainee. He subsequently became a turn foreman in the open hearth blooming mill and a welder foreman in the electric weld tube mills. In 1956, he was promoted to mechanical engineer for the Mechanical Department, the position he held until taking over his new assignment.

Walter G. Stiffler has joined the Reliance Electric and Engineering Co. as senior insulation engineer at the company headquarters in Cleveland, Ohio. Mr. Stiffler will direct the engineering and development activities which involve electrical insulation for all of the company's products which include electric motors, gearmotors, electrical and mechanical speed drives, electronic and magnetic controls and regulators for industrial and marine purposes.

Melville M. Mitschrich has been appointed assistant to the director of engineering services of Allis-Chalmers Manufacturing Co. Mr. Mitschrich joined Allis-Chalmers in 1955 as a sales representative in the St. Louis, Mo., district office. Since 1959 he had been an analyst in the company's sales and market analysis department.

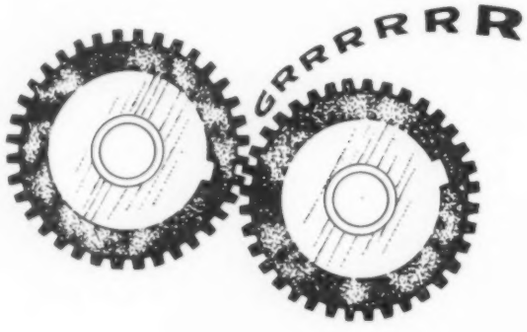
Stuart O. Schaefer has been named Detroit plant industrial engineer, Jones & Laughlin Steel Corp.'s Stainless and Strip Division. He formerly was industrial engineer at the Louisville, Ohio, plant. **Richard L. L. Watterson** has been appointed plant industrial engineer at Louisville. He formerly was a group leader in the Industrial Engineering Department at the Jones & Laughlin Cleveland Works Division. Mr. Schaefer joined J&L as an industrial engineering trainee at the Pittsburgh Works in 1953, coming to the Louisville Plant in 1958. Mr. Watterson started with J&L in 1955.

Dr. Thomas A. Prater has been appointed manager of the process laboratories unit of the General Electric Co.'s research laboratory. Dr. Prater is returning to the research laboratory from the general engineering laboratory. Before this assignment, Dr. Prater had been with the research laboratory since 1952. He has specialized in the study of alloys for high temperature applications, such as steam turbines and jet engines, and has published many papers and reports on such metals. Dr. Prater first joined General Electric in 1951 as an engineer in the Metallurgical Products Department.

Obituaries

J. D. Scully, who retired in 1951 after 46 years of service with National Tube Co., died January 14. Mr. Scully was general maintenance foreman at McKeesport, Pa., at the time of his retirement.

Anton W. Schmitz, manager of equipment engineering for General Electric Co.'s Industry Control Department, Salem, Va., died December 2. He was 55. His 37-year career with General Electric included 16 years as a design and application engineer.



When rolling mills "grind their teeth," are your own inclined to do the same? We have something to prevent just that sort of trouble. FERRO-FILTER Magnetic Separators, installed in lubricating systems of mill equipment, will extract even the smallest abrasive ferrous particles that cause scoring and wearing of gears and bearings. You can save a mint of money by reducing top-heavy maintenance cost and equipment shutdowns. For more complete information, write for bulletin. S. G. Frantz Co., Inc., 442 Kline Ave. at Brunswick Pike, Trenton 6, N. J.

IN STEEL MILLS

WEIGHT LIFTING MADE EASY

Yuba designs and builds all types of custom steel cranes with lifting capacities of 5 to 1000 tons, for indoor or outdoor service.

Yuba-Bedford Steel Mill Cranes are working to plant capacity —24 hours a day —year after year

Two generations of steel makers have operated Bedford Cranes in mills from Pennsylvania to Peru. These are mills where the handling jobs are tough—where cranes work shift after shift under all conditions —and where there's time for only routine maintenance.

Hundreds of Bedford Cranes have been manufactured for leading steel producers...cranes that are specially designed and custom-built by Yuba to the tough requirements of the steel industry. Big lifting problems are made easy on every shift—for years!

Yuba designs, builds and erects all types of cranes including bridge, unloading and material handling, gantry and semi-gantry, floating and jib cranes. Also derricks, hoists and launching towers for defense ordnance.

YUBA

specialists in steel mill cranes and custom cranes of all types

YUBA-BEDFORD CORP.

1108 Fifth Street, Bedford, Indiana • A subsidiary of

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Atlanta • Buffalo • Chicago • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Seattle

Servo Power satisfies more

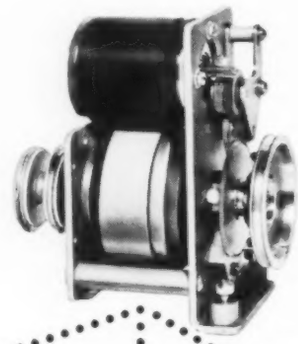
in Taylor TRANSCOPE® Electronic and Pneumatic

Powerful SERVOMATIC motors in Taylor TRANSCOPE Recorders not only give you greater recording accuracy than ever before, they also supply the power necessary for precision operation of auxiliary mechanisms and computing devices. Power in the pneumatic servo is 150 times greater than the bellows type; in the electronic it's 1,000 times greater than galvanometer systems.

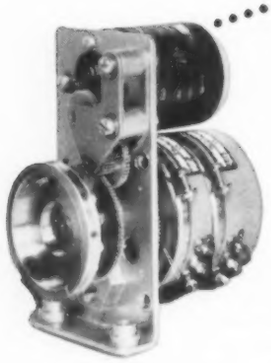
This means closer measurement of temperature, pressure, flow, flow ratios, pH and other process variables—whether the signals are pneumatic or electric. Accuracy of ½ of 1% is standard, ¼ of 1% optional.

You economize with servo power because you no longer need conventional "black boxes" for auxiliary functions. You save on panel space . . . and installed cost.

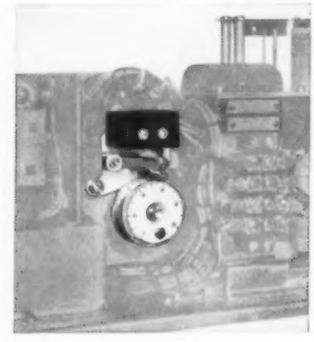
Optional features made possible by servo power include integral process alarms, retransmitting potentiometers, function generation and digital output with encoder discs. Ask your Taylor Field Engineer to demonstrate the built-in plus value of servo power in the TRANSCOPE line. Or write for **Bulletin 98286** (Pneumatic) or **98335** (Electronic). Taylor Instrument Companies, Rochester, New York, or Toronto, Ontario.



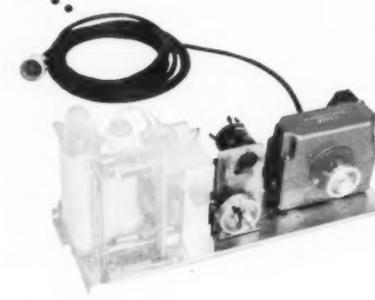
700J ELECTRONIC SERVO MOTOR
Precision gearing couples servo to a precise feed-back device with high torque. Built to military specifications.



RETRANSMITTING POTENTIOMETER
permits numerous computations such as xy, $\frac{x}{y}$, $\frac{xy}{z}$, $\sqrt{x}$.



INTEGRAL ALARMS
cost approximately 1/3 as much as conventional external "black boxes".

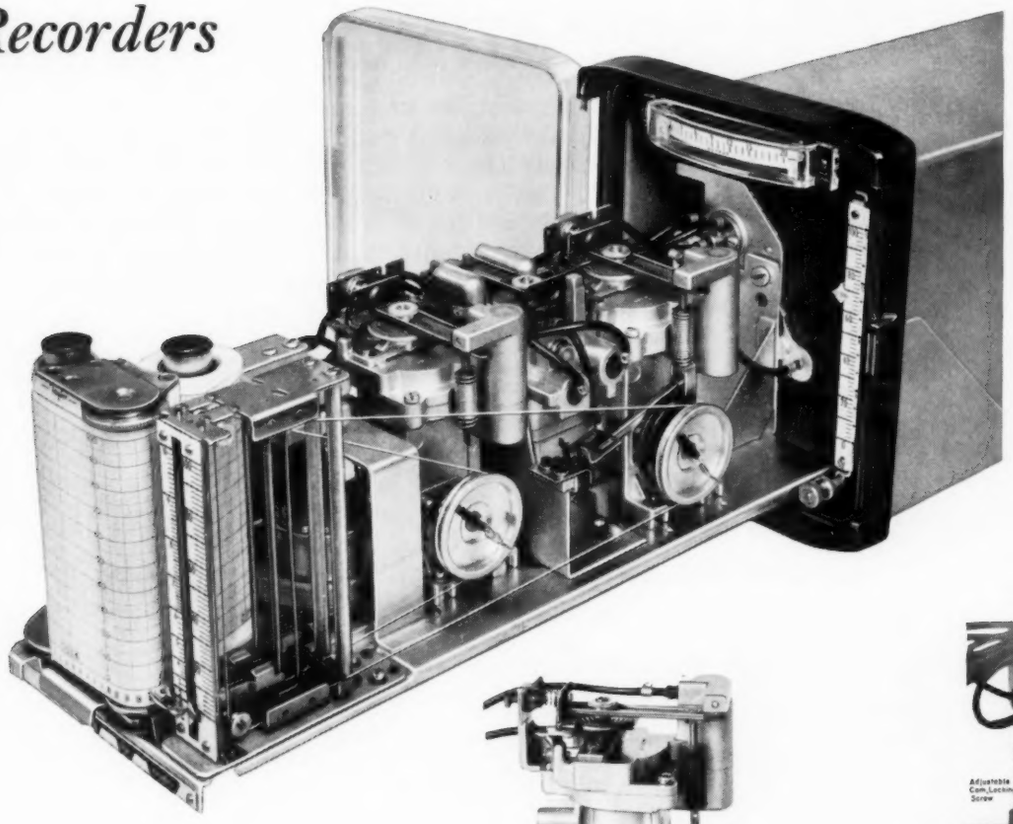


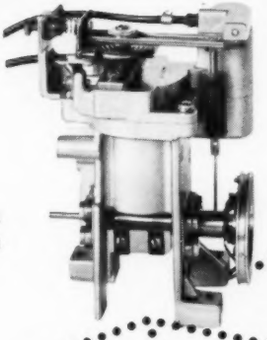
DIGITAL ENCODER
—servo motor permits use of compact, high accuracy, integral encoders.

Taylor Instruments

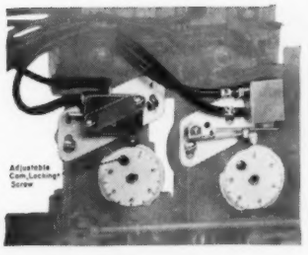
process needs more economically

Recorders

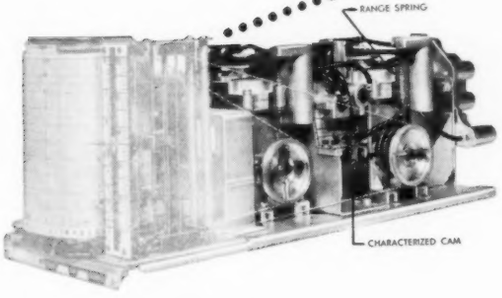




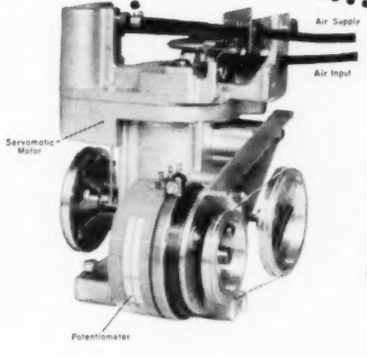
90J PNEUMATIC SERVO MOTOR
Essentially a power piston with built-in positioner. Solid construction assures long, trouble-free life.



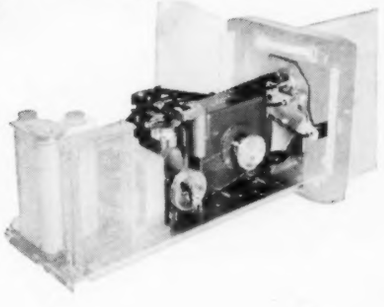
INTEGRAL ALARMS
Alarm points convenient to set on calibrated dials.



FUNCTION GENERATOR
puts square root extraction and other similar functions within recorder.



POTENTIOMETER
costs about half as much as usual "black box" transducers.



DIGITAL ENCODER
sets new standards of accuracy for pneumatically driven encoders.

MEAN ACCURACY FIRST

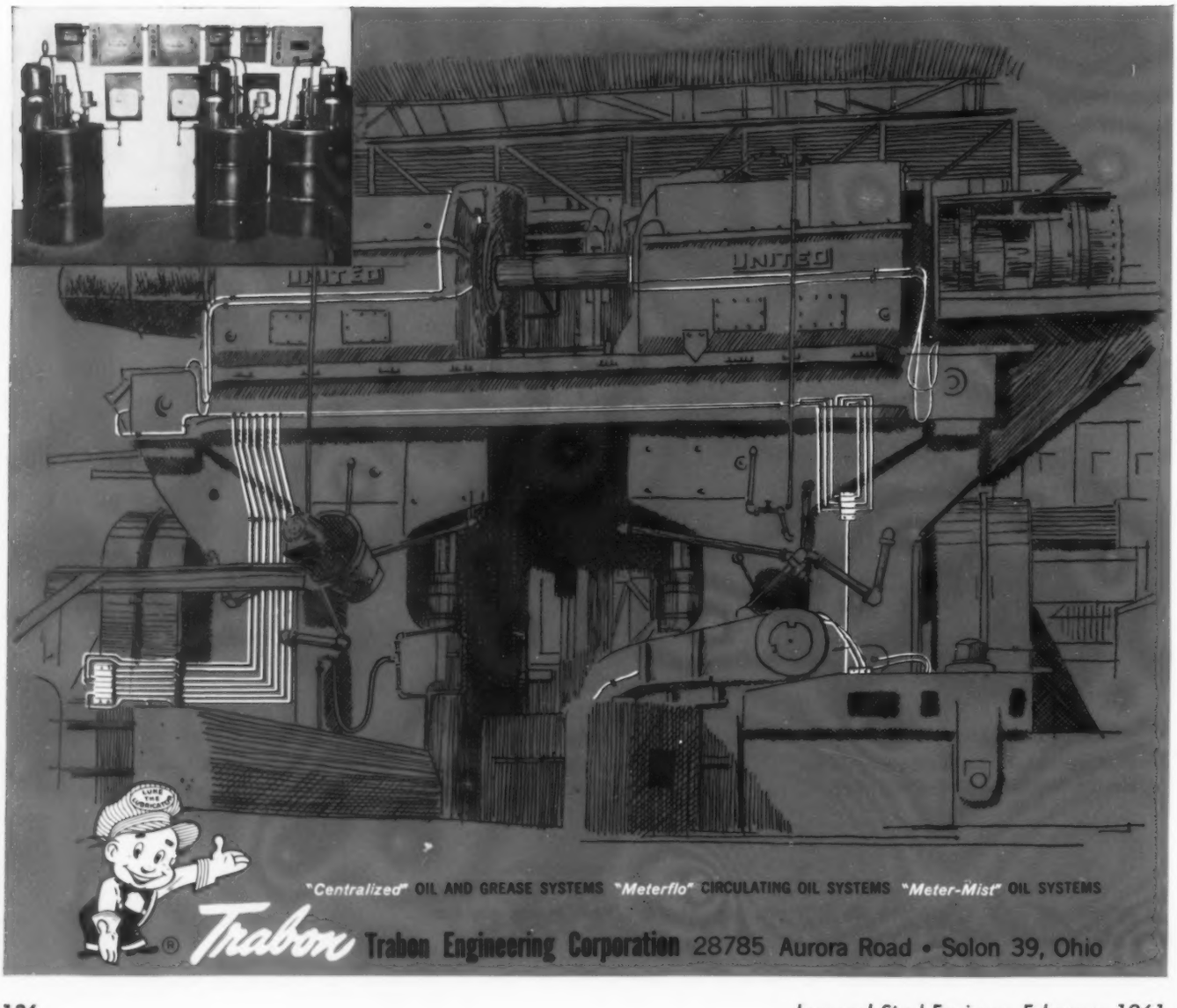
TRABON®

CENTRALIZED LUBRICATING SYSTEMS

When tonnage has to be made, Republic Steel's modern 45" slabbing mill can really make it. But tonnage depends on the mill operating efficiently day after day and that's where Trabon Centralized Lubricating Systems help. Trabon automatically delivers exact amounts of grease to all bearings on the mill, runout table and manipulator. Some bearings demand grease on a 5 minute "on" — 10 minute "off" schedule. Other bearings need grease less frequently. Trabon does all these critical greasing jobs positively. The small inset photograph shows the Trabon control panels and hydraulic barrel reservoirs which "time" the delivery of the lubricant throughout the mill area. In addition, each bearing has built-in Central Warning to alert the work crew in case a line is smashed or blocked in some way. This explains why steelmen rely on Trabon for **production** and profit **protection.** Why don't you call a Trabon representative for full details today.

Republic Steel's 45" slabbing mill lubricated by Trabon

Nothing left to chance — Central Warning protects profits


"Centralized" OIL AND GREASE SYSTEMS "Meterflo" CIRCULATING OIL SYSTEMS "Meter-Mist" OIL SYSTEMS
Trabon
Trabon Engineering Corporation 28785 Aurora Road • Solon 39, Ohio

Equipment News...

FUSED ZIRCONIA

△ Fused stabilized zirconia refractory has recently been placed in service in its first commercial application as a refractory for furnace construction.

A furnace designed to operate continuously at elevated temperatures in the vicinity of 2200 C (3992 F) has been built with the hot-zone lined with fused stabilized zirconia manufactured by Norton Co. The heating elements are specially selected and machined tungsten rods. The furnace can be operated with hydrogen or other reducing or inert atmospheres compatible with the furnace materials.

The pilot model of this furnace was built to provide a means of sintering large pressed tungsten ingots. Heating the metal for as little as one hour in the hot-zone of the furnace has increased the metal density sufficiently to permit hot working to reduce the diameter of the ingot.

This ultra-high temperature furnace has many potential uses in the study and production of special ceramics, cermets and refractory metals. The hearth opening on the pilot model is 5 in. x 8 in. Building a furnace with a larger cross section appears to present no particular problems from a design and engineering standpoint.

The advantages of the rod furnace design are the almost limitless possibilities of hearth shape and size which are possible. The work to be heated is passed through the hot-zone, tunnel-kiln fashion. Production models of this furnace will be equipped with a specially designed internal stoker which will carry the work through the furnace without rollers or bearings in or near the hot-zone.

Since these high temperature rod furnaces are designed to take loads in excess of 1500 lb, the feeding of the work from entrance to cooling chamber represents a serious problem. The handling of extremely hot, heavy metal pieces has been solved by the use of a "walking beam" construction based on a reciprocating rod conveyor mechanism principle.

The conveying mechanism is a self-contained unit, operating entirely within the furnace chamber and is not dependent upon any conveyor drive at the entrance or exit zones. The beams which actually touch the hot work and carry it forward are made of refractory metal and are protected in their contact with the hot work by the furnace atmosphere.

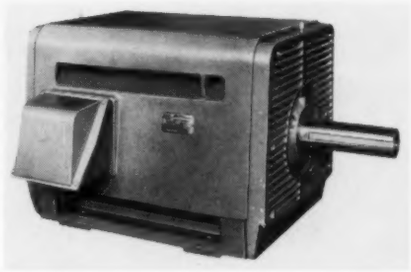
A key to the success of this furnace was the use of the zirconia bricks which have a maximum use temperature of 4400 F. These bricks line the hot-zone and support the tungsten heating elements. There is no chemical or electrical reaction between the zirconia and the heating elements.

Zirconia in molded shapes and as loose grain has been widely used in the past ten years in high temperature applications. However, its use has been primarily in research fields, many in the area of government sponsored research into high temperature conditions. Other applications of zirconia have been in specially engineered industrial heating devices and in the form of batts for firing titanates. This new furnace, designed and built by C-M Manufacturing and Machine Co. represents the first commercially available resistance heated equipment useful to this temperature.

A-C MOTOR

△ The Reliance Electric and Engineering Co. has announced a new a-c motor, called the Duty Master D-5000, which has a round stator inside its nearly square frame. This unusual arrangement provides better cooling, permitting using a smaller over-all dimension for any given horsepower rating.

The D-5000, which is available from 125 through 300 hp, has large air intakes which cover each end of the motor. Air is drawn in these



louvered openings, ducted through the rotor and stator, and then exhausted at the sides. The result is more efficient cooling and more horsepower.

Class B insulation is standard on the Duty Master D-5000 and frames and end louvers are cast iron. The louvers can be removed for inspection and maintenance.

The motor is being offered with either sleeve or ball bearings. Drip-proof enclosure is standard, but splash-proof enclosures can be specified. In addition, encapsulated stators are available for severe conditions.

Either 220, 440 or 550 line voltages are available for 3600, 1800, 1200 and 900 rpm operation. A totally-enclosed fan-cooled design will be available soon, and horsepowers up to 2000 will be ready in early 1962.

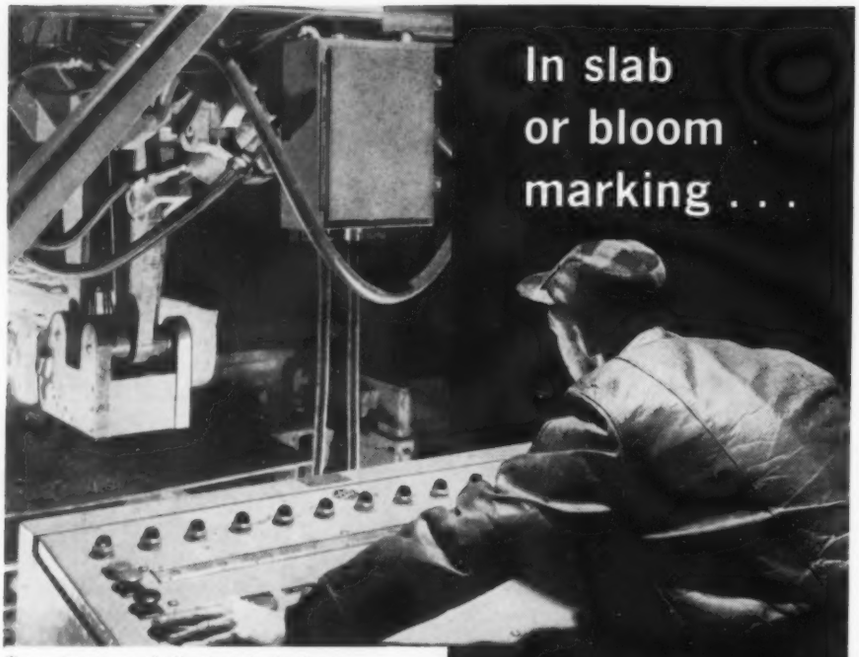
A-C COMPRESSOR

△ Redesign of its intercooled centrifugal compressors (Type VC) to provide water cooling between all stages has been announced by Allis-Chalmers Manufacturing Co.

The redesigned unit, for applications requiring 60 to 125 psig air, provides increased efficiency, reduced space requirements, and simplified maintenance compared with conventional two body uncooled centrifugal machines.

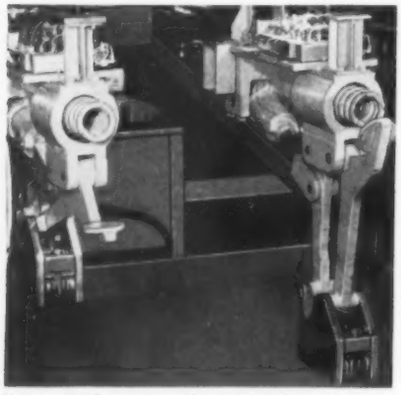
Standard air-to-water heat exchangers cool the air stream passing through the compressor. The intercoolers are mounted after each impeller, both in the upper and lower half of the machine's single horizontally split casing.

Air enters the compressor through

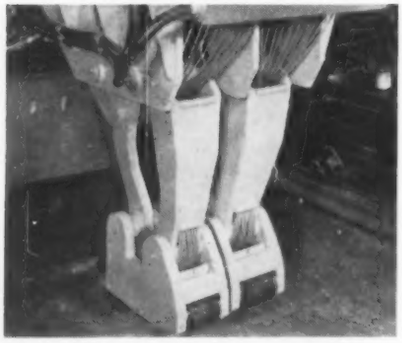


In slab or bloom marking . . .

Operator presses button to actuate stamping cycle or change characters—installed at a transfer table.



Twin units for automatic consecutive numbering of 2½" bar billets—for installation along edge of cooling bed.



Double-headed Slab Marker with 18 stamping wheels, photographed during testing—for installation over a roller line.

CUNNINGHAM HAS THE EXPERIENCE

17 UNITS IN SERVICE . . . MORE ON ORDER

Under constant development for more than 13 years, Mecco Safety Slab Markers are the industry's most advanced—*the most thoroughly service-proved*, by a margin of hundreds of thousands of tons.

May we send a comprehensive technical bulletin on Slab Markers?

Mecco SAFETY MARKING TOOLS

M. E. CUNNINGHAM CO.
1041 CHATEAU STREET
PITTSBURGH 33, PENNA.

a standard nozzle, passes through one stage of compression, then to the first heat exchanger and to the next impeller. The cycle is repeated stage by stage until the air is discharged after the last stage.

The redesigned compressor is available from 5000 to 60,000 cfm.

STRAPPING STATION

△ The M20-SV, a new semi-automatic strapping station for narrow strip coils, has been announced by Signode Steel Strapping Co.

The M20-SV incorporates an M20 power strapping machine head which is mounted above a roller conveyor table to a ballbearing slide and supported by counterbalanced arms. This suspension system allows fingertip positioning of the power strapping machine. A force of only 3½ lb on the adjusting handle positions the PSM anywhere in its 21-in. vertical range and 14 in. of horizontal travel.

The overhead mounting keeps particles and dust out of the power strapping machine, places the seal on the top face of the coil where it is visually inspectable by the operator and where it cannot be damaged by the conveyor rollers.

Two tapered radial rolls, for coil indexing, are mounted within the conveyor table. These radial rolls are raised and lowered pneumatically.

The M20-SV will place any number of radial straps on coils as large as 60 in. OD, 24 in. ID, and 16 in. wide, as small as 19 in. OD, 13 in. ID, and ⅜ in. wide. The maximum coil weight that can be handled is 4000 lb.

With the coil in position, the M20-SV operator adjusts the strapping machine to the particular coil width. The strap feeding cycle, controlled with a push button in one adjusting handle, directs the strap down through the coil ID and out toward the operator. He then places the strap end in the strapping machine and starts the tensioning cycle with a pushbutton in the other handle. The operator does not have to reach across the coil slit edge to pick up the strap.

The unit is factory-adjusted for any one strap width from ⅜ in. through ¾ in. Strap tension is easily adjustable on the machine, within a range of 50 to 1500 lb.

Power-driven conveyor and indexing rollers are available as optional equipment.

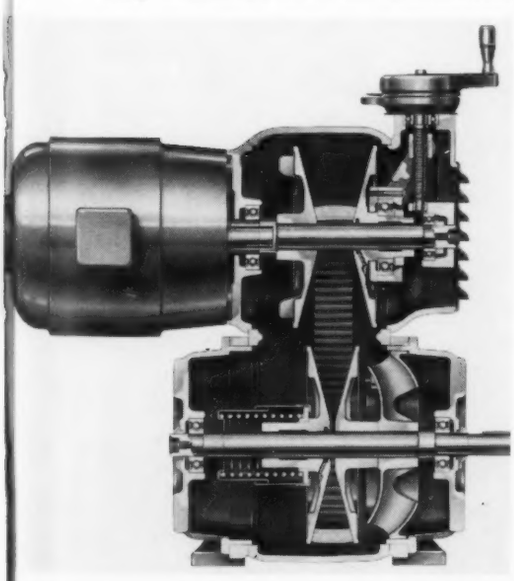
VARIABLE SPEED DRIVES

△ The Industrial Products Division of Western Gear Corp. has announced the design and manufacture of a complete line of mechanical variable speed drives which it is marketing to industry under the trade name "Vari-Master." It is the first mechanical variable speed drive designed to customer requirements.

Vari-Master is available in three sizes, covering the horsepower range of from 1 to 10 hp with a wide speed range of up to 8 to 1 ratio of speed variation. The drive is offered in both drip proof and totally enclosed construction. A standard, NEMA "C" face motor, with standard shaft extension is utilized. The motor can be of drip proof, totally enclosed or explosion proof design.

The drive embodies a number of engineering features, many of them exclusive. For example, Vari-Master uses a fan on the variable speed shaft to allow maximum cooling of the belt and longer belt life. Disks are positively positioned by shaft shoulders, thus there is no possibility of belt misalinement. The constant speed disk assembly is saddle mounted on its own bearings, allowing vibration-free operation. Disks are amply sized to permit long, trouble-free belt life.

The transmission case is tightly wrapped around the disks permitting maximum over-all dimensions.



All bearings are double sealed, permanently lubricated. Shafts and keys are heavy chrome plated and ground to close tolerance. Disks have large grease reservoirs.

The drive uses the Western Gear Strait Line gear reducer to provide low output speeds. This helical gear reducer is offered in double, triple and quadruple step reduction, providing a large selection of output speeds. It is offered in a wide variety of assemblies, both horizontal and vertical, to fit nearly any space requirement. Vari-Master can be equipped with manual (handwheel) control, electric remote (push button) control or pneumatic automatic control. A wide variety of speed indicating tachometers are available.

GOGGLE VALVE

△ A newly-designed mechanical goggle valve, used in steel mill gas mains, has been placed on the market by the Metal Products Division of Koppers Co., Inc.

The valve features all-welded, stress relieved valve bodies and has been shop tested under conditions of elevated temperature and pressure. The jackscrews are made of chrome nickel alloy for maximum toughness and strength. In addition, the goggle plates and plate seats are replaceable while the valve is in service.

The valve body is constructed of two identical weldments designed to withstand a clamping stress of 1000 lb per linear inch of sealing circumference. The two weldments are machined as a unit to insure parallel seating surfaces and leakproof operation. Since all the bolt holes of the goggle plates are jig drilled, the parts are interchangeable and replaceable.

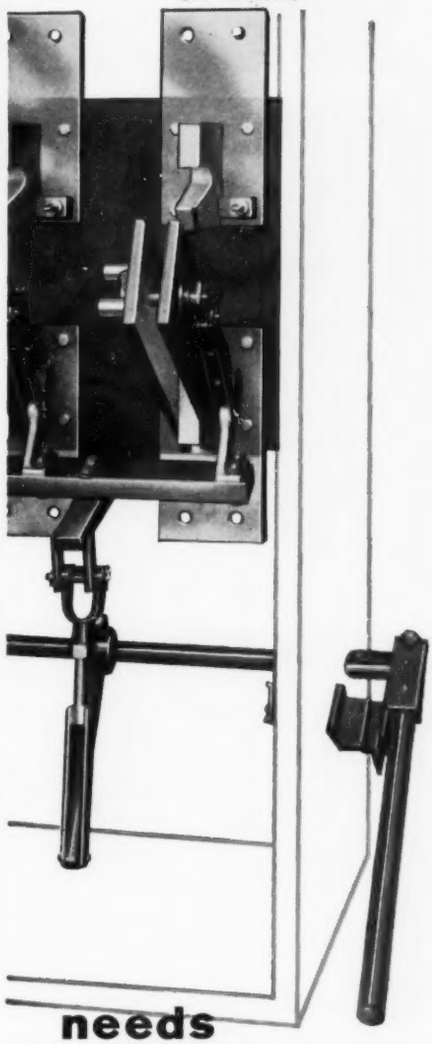
The new goggle valves will be made in a range of sizes to fit gas mains from 24 in. in diam to 108 in. These valves can be provided for either hand or motor operation.

BEARING RETAINERS

△ A new alloyed iron material for roller bearing retainers has been announced by the Rollway Bearing Co. Known as Rollube, the material has a number of advantages over the conventional

RARELY

(IF EVER)



needs

MAINTENANCE

Pringle disconnect switches for high-current equipment carry as much as 50,000 amperes, continuously, with no more of a heat rise than you would get from copper bus bars bolted together. These switch blades actually are bolted together. Under a constant pressure of 600 lbs./sq. inch. Without springs. Yet, they open easily after months (or years) of closed operation. Heat, fatigue, lack of movement won't affect the operating mechanism. Constant, periodic maintenance is unnecessary.

Less complex than most high-capacity disconnect devices. Less expensive too. Available in single- or multi-pole models, front or rear connected, live front or steel enclosed. With or without high-capacity fuses. For use on crane conductor rails, transformer secondaries, or AC and DC switchboards. Wherever high-current equipment must be isolated for periodic servicing.

Write for Industrial Switch Catalog

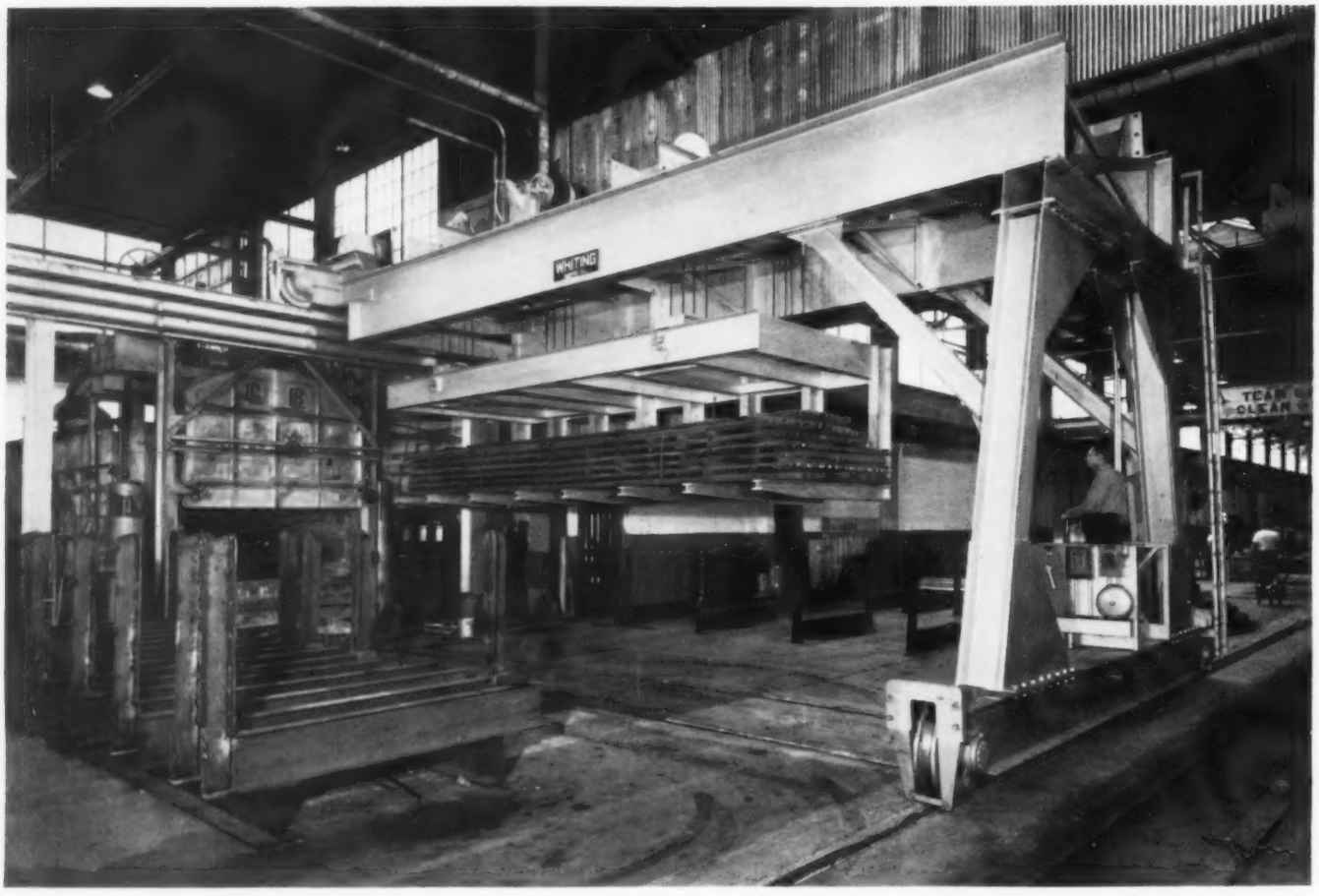
PRINGLE

ELECTRICAL MANUFACTURING CO.

1904 NORTH SIXTH STREET
PHILADELPHIA 22, PENNA.

WHITING

WE WORKED TOGETHER WITH BLISS & LAUGHLIN TO BOOST FURNACE CAPACITY 20%



The Whiting gantry crane **above** relieved a staggering bottleneck at Bliss & Laughlin's busy mill in Harvey, Illinois. Four heat treating furnaces are now speedily loaded and unloaded in contrast to a system that was arduous, time-consuming and costly. The new gantry has stepped up furnace capacity over 20% and cut maintenance on furnaces and loading cars. B.&L.'s service to customers has greatly improved.

A simple solution? Yes. But B.&L. engineers had been nettled for years by the heat treating log jam. They considered many possibilities including lift trucks.

There is a kind of "togetherness" that operates between Whiting and our customers and the solution Bliss & Laughlin found is an example of how it works. We may be able to help you too—and what we recommend, we back up by product performance. Let's get together.

Want details? Write for brochure No. 93 Whiting Corporation, 15655 Lathrop Ave., Harvey, Illinois

See our catalog in Sweets

90 OF AMERICA'S "TOP HUNDRED" CORPORATIONS ARE WHITING CUSTOMERS

CRANES

WHITING

MANUFACTURERS OF CRANES; TRAMBEAM® HANDLING SYSTEMS; PRESSUREGRIP; TRACKMOBILES®; FOUNDRY, RAILROAD, AND SWENSON CHEMICAL EQUIPMENT

bronze, and is now being used as the standard retainer material for many of the company's thrust and radial bearings.

Principal advantages of Rollube retainers over bronze are that it will operate at temperatures up to 800 F; it has a coefficient of expansion very close to that of steel; it will operate very satisfactorily under conditions of boundary lubrication; and permanent expansion or growth at elevated temperatures is much lower with Rollube than with bronze.

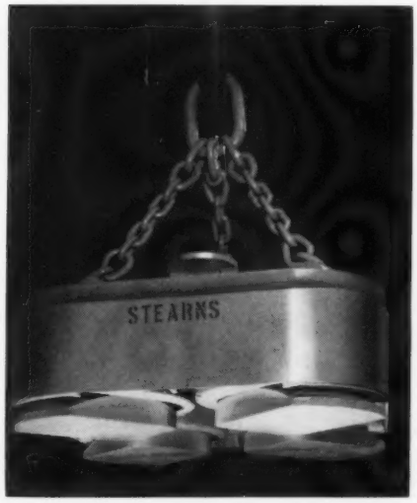
Rollube also is lighter than bronze, and has a yield strength about 1½ times that of bronze.

COIL LIFTING MAGNET

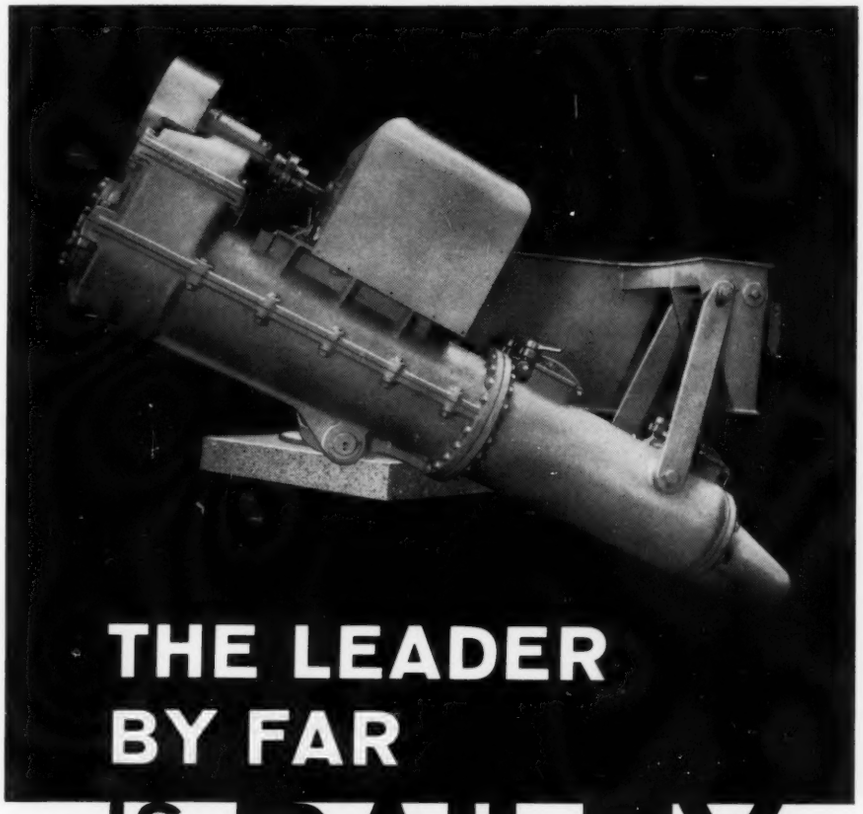
△ A line of 4-pole magnets designed to permit faster, safer and damage-free handling of hot or cold strip coiled sheet steel is announced by Stearns Magnetic Products. These magnets are available in sizes to handle coils weighing up to 80,000 lb.

Each of the unit's four poles is a separate magnet with its own class H, high temperature insulated coil. Coil assemblies are completely enclosed and watertight.

Here is one of three large coil handling magnets recently shipped to a leading steel producer by Stearns. These units were ordered to handle hot coils (on end) ranging up to 68 in. OD and 28 in. ID with strip widths from 24 in. to 56 in. Strip coil temperatures range from 1000 to 1200 F when lifted. With only 20 per cent of coil end area in actual contact with magnet poles and the remaining 80 per cent presenting a ¾ in. air gap, these units will handle a 34,000-lb coil. The magnet is rated to provide 150 per cent lift at 80 per cent voltage.



IN CLAY GUN PERFORMANCE...



THE LEADER BY FAR IS BAILEY

Extremely accurate and fast positioning, Bailey Clay Guns furnish the high clay pressures (642 to 1150 psi) which are so necessary with the new coke-tar tapping hole mixes now being used on many furnaces. Unique mounting and 3-motor operating system assure quick and reliable positioning in the tapping hole. There are more than 170 Bailey Clay Guns in blast and electric furnace service.

• *Write for bulletin.*

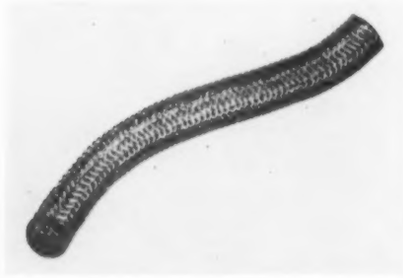
WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA.

Stainless steel enclosures are designed specifically for steel mill requirements, incorporating an exclusive heat barrier to protect magnet coils. A heavily constructed housing protects the lead-ins and waterproof terminal box.

FLEXIBLE CABLE

△ A new, large capacity, multiconductor electric cable, described as the first that can be safely bent and looped with the flexibility of a pliant rope, has been announced by Electric Arc, Inc.

The new cable, which is called "Ni-Coil," is expected to find particularly wide application as the induction coil in stress relieving with induction heating, and as an



easily installed and economical replacement for braided shunts used as electrical conductors between moving parts.

The cable is made with multiple nickel plated conductors encased in a woven niplate copper sleeve and in sizes ranging from 210,000 to 500,000 circular mills, with capacities of from 260 to 1000 amp.

Construction of the cable provided for more even current distribution, and less skin effect and easy positioning for best results in induction heating. As a flexible electrical conductor, the cable provides a number of important advantages, including minimized heating when carrying heavy alternating current, improved terminal contact, reduced bulk and simple installation.

POTENTIOMETER

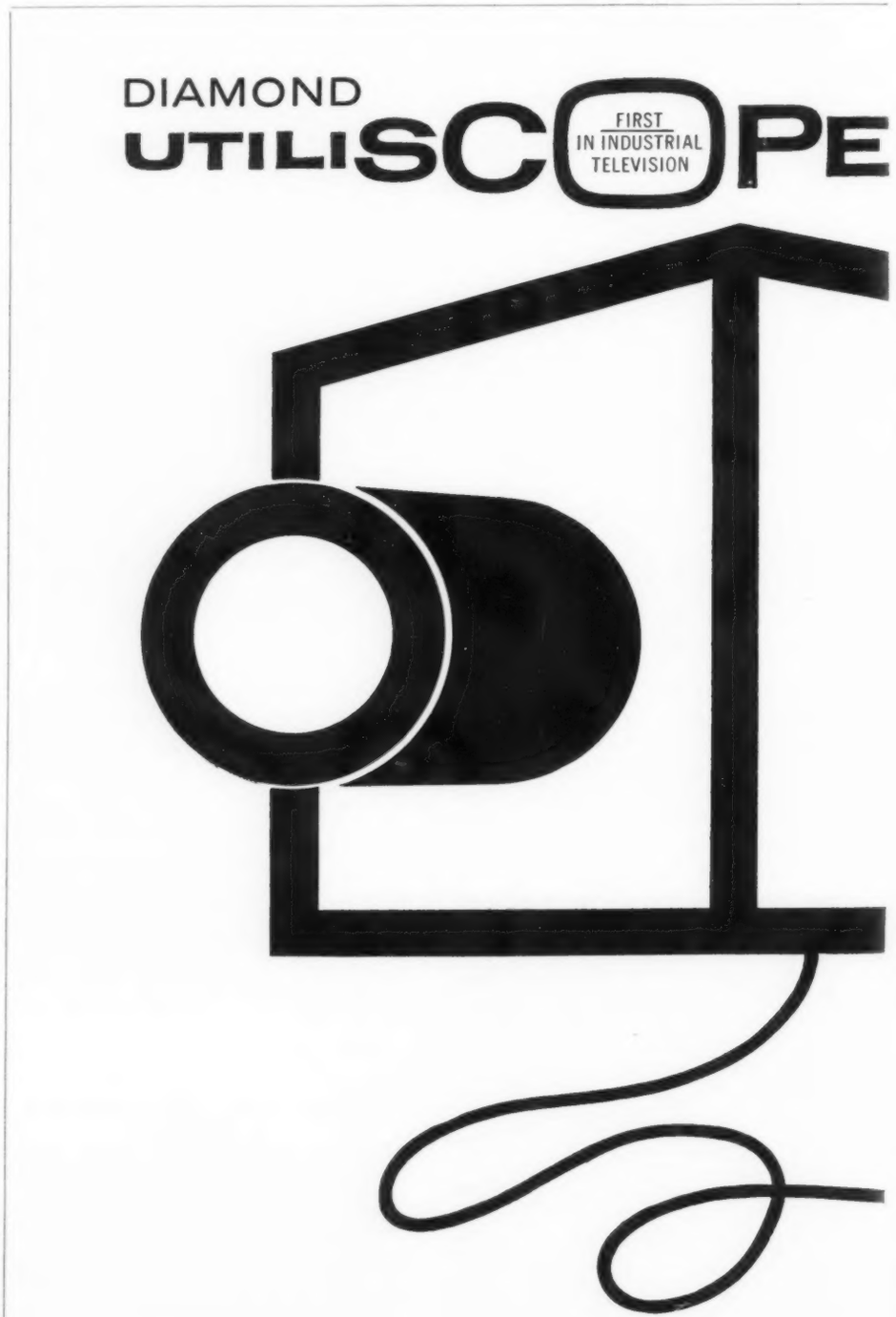
△ Introduced by Brown Instruments Division of Minneapolis-Honeywell Regulator Co. is an industrial process potentiometer, the ElectroniK 17, which incorporates an extremely accurate, trouble-free electro-mechanical strain gage as the rebalancing element.

In eliminating the conventional slidewire, infinite resolution is achieved. No longer is the number of points at which a potentiometer can come to balance limited to the turns (convolutions) on a slidewire.

Initial production of the new potentiometer, which can be mounted in a standard 19-in. relay rack, on a panel or bench or made portable, will consist of a single pen strip and circular chart recorders and a circular scale indicator, each with or without control.

In addition to the radically different rebalancing mechanism, known as the Stranducer, the ElectroniK 17 incorporates these features for the first time in a basic potentiometer:

(1) Isolation of all critical components within an electrical shield, thus rejecting stray signals that cause recording errors and affect the dynamics of the instrument. Stray signals having 60-cycle rms values five times greater than span, and voltage to ground strays of 300-volts d-c or 150-volts a-c, will not impair accuracy of the ElectroniK 17.



(2) One true reference junction compensation for all types of thermocouple actuation.

(3) Transistorized plug-in control units up to a maximum of eight set points for auxiliary or zone control. Any combination of these can be supplied as original equipment or modified as required by the user in his own plant. Compact transistor units control the contract action of single-pole double-throw relays and a single plug-in power supply furnishes input signals to all control system components.

The Stranducer varies the output potential of the measuring circuit to balance the input signal from the process variable.

Four prestressed looped wire strands enclosed in an I-shape frame form the variable resistance legs of the measuring circuit. Their resistance varies in proportion to the tension applied to them.

At zero position, the wires, fastened to the pivot arm of the Stranducer, are in equal tension and are of equal resistance. The pivot arm, as it rocks back and forth, increases tension on two of the wires and decreases it on the other two wires. It is linked mechanically through sector and strap reduction stages and the drive cable to the balancing motor.

The ElectroniK 17 has two amplifiers—one solid state and the other with vacuum tubes and transistors to use the advantages of both. Both are interchangeable with plug-in connections.

Modular construction gives the unit flexibility and versatility. Each module is a complete interchangeable assembly or subassembly. The measuring circuit can be changed for different ranges or actuations by substitution of range cards and actuation boards. The drawer-type chassis, with its wiring drawbridge, can be pulled out for instrument adjustment or service without disrupting operation.

The front or display module can be easily removed and replaced, depending upon the model, with a strip or circular chart recorder or circular scale indicator. For example, a chart record, often desirable in process startup, may no longer be needed once the process is in operation. The interchangeable module permits the user to start out with a recorder and later change to an indicator.

Calibrated accuracy of the ElectroniK 17 is ¼ per cent. Strip chart instruments have pen speeds of 1, 5 and 15 sec. Those for circular chart instruments are 5 and 15 sec.

LIMIT SWITCH

△ A new open precision snap-action limit switch designed to bridge the gap between the very small and somewhat fragile limit switches and the larger, enclosed limit switches has been added to General Electric Co.'s control line.

The new unit will handle high accuracy, fast response applications where space is limited.

Available with one normally open, one normally closed, or one normally open and one normally closed contact, the new switch is offered with either plunger or roller lever operators.

The precision snap-action switch is rated as follows: a-c, up to 40 amp make, 15 amp break; d-c, up to 2 amp make and break on single throw forms with 0.040 gap. Single

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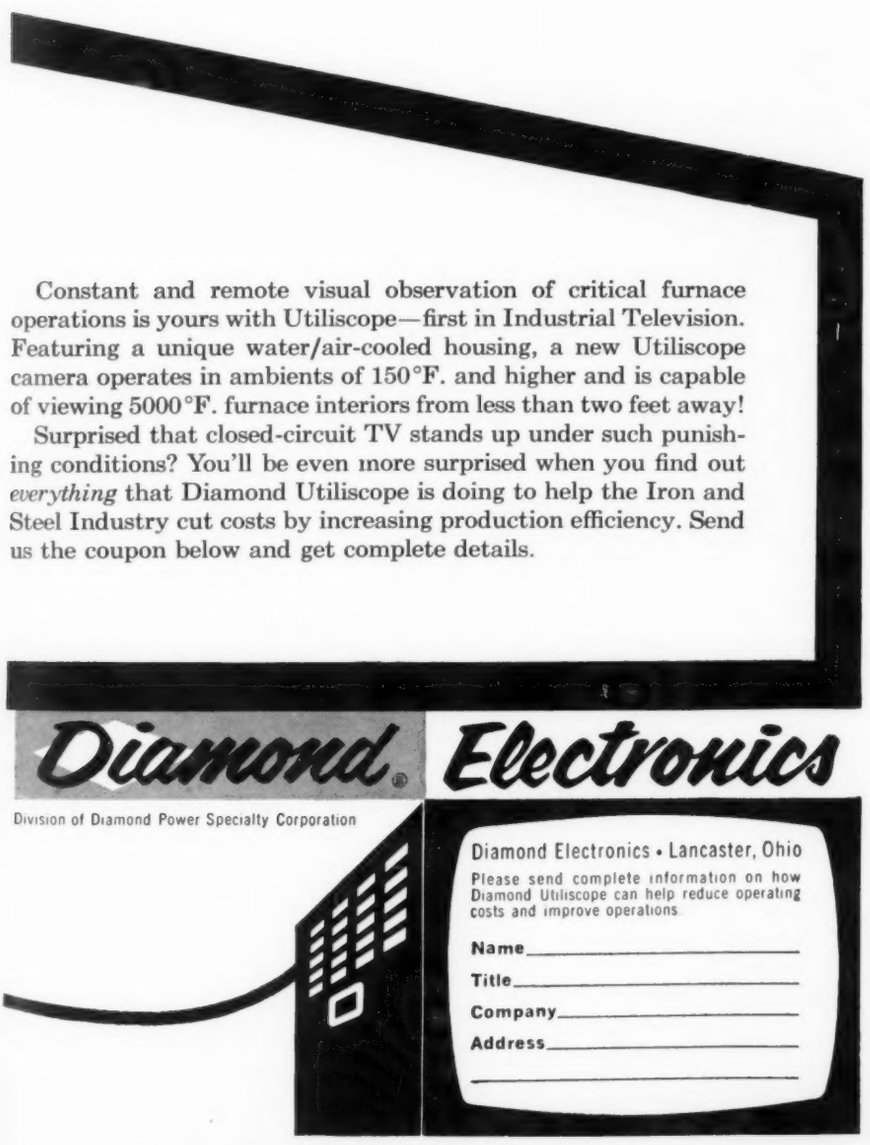

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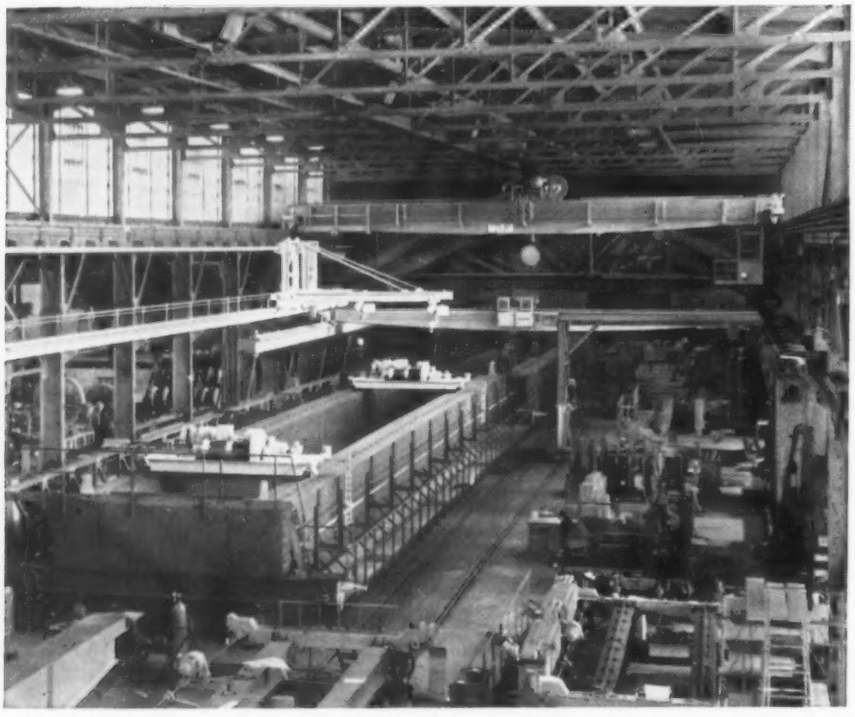

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throw switches are suitable for one-half horsepower, 115 volts or 230 volts a-c. All forms are available from 110–600 volts.

SINTER BREAKER

△ A new type breaker for crushing sinter as it is delivered from the sintering machine has been developed by McLanahan & Stone Corp. Using integral nine in. hard-surfaced teeth to crush the sinter against special alloy grizzly bars, the breaker was developed for heavy-duty, continuous service in crushing extremely abrasive, high-temperature materials.

The sinter breaker currently is available in two standard widths, 72 in. and 94 in., each with a roll diameter of 24 in. Water cooling is available for the crushing roll and roll shaft bearings. Design is such that the breaker crushes any volume of material that can be discharged to it by the sintering machines.

The frame and housing are of fabricated steel construction, the main members being 1½ in. plate. The housing has ¾ in. thick abrasive-resistant, renewable side liners—as well as a fabricated steel cover plate with hinge lugs and lifting loops to allow access to the breaker roll if maintenance is required. The grizzly bars have a nominal size of 4 in. x 8 in. x 4 ft 4 in., tapered to prevent plugging. These are easily renewable when the grizzly anchor plate is removed. Automatic lubrication for the bearings is a feature.

Drive components consist of a quadruple-width chain, 80 tooth driven sprocket and a 16 tooth drive sprocket. A horizontal motor reducer is used to obtain necessary reduction and to produce a breaker roll speed of 20 rpm.

PUMP MOTORS

△ A new design in weather protected hollow shaft pump motors making available higher horsepowers—up to 800 hp—with the advanced design features of the U. S. Holloshaft Type HU, has been released by U. S. Electrical Motors Inc.

The new motors are more than six ft tall, with mounting base diameters of 30½ in. and 24½ in. They are available in 3 or 2 phase, 60 cycles, with Class A insulation 40 C

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rating or Class B insulation 60 C rating. These motors, like the other Type HU motors above 125 hp, are formwound—and are available up to 800 hp with standard insulation or with U. S. Everseal Silicone Rubber Insulation which protects windings against adverse environments such as high ambient heat, chemicals, abrasion, moisture, vibration, oxidizing, fungus, salt air, spray, oils, detergents, and exposure to extreme weather conditions.

Ranging from 100 to 800 hp, the new Frame 689 motors are available with speeds from 400 to 1800 rpm and thrust capacities from 11,280 to 8000 lb. Voltages available are 220, 440, 550 volts from 100 to 200 hp inclusive, and 440, 550, 2300 volts from 250 through 800 hp.

Design features of these new Frame 689 motors provide weather protection in excess of NEMA specifications for Weather Protected Type I. Protective grille and large baffled air opening permit low velocity air cooling. Faster oil-filling and minimum spillage are provided by the Lubriport which can be pulled out to give an extended opening, and which provides a window for visual oil check when in normal operating position.

A unique lock bar holds the shaft during adjustment, taking the place of an extra helper. These motors are protected against momentary upthrust at starting. An optional feature is the Ballomatic backstop to prevent shaft backspin due to recession of water column when motor is stopped. Rotating parts are dynamically balanced before assembly, and assembled motor is vibrometer-tested for balance while running, to assure smooth operation and longer life. Safety-lock lifting lugs prevent hoist sling from slipping out during installation, and make hoist handling easier. A rodent guard at the bottom of the motor prevents reptiles and small animals from entering ventilation openings.

WELDING PROCESS

△ Air Reduction Sales Co. has introduced a new welding process—called Aircomatic CO_2 Sprayarc—for welding of mild steel which combines the use of carbon dioxide and a low alloy steel welding wire.

The new process employs the economies of CO_2 welding with

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Another Hallden First — type 76 Guillotine Flying Shear, the world's largest, for continuous strip shearing — up to 5/8" thick, 100" wide aluminum — at ***two cuts per second.*** This new Hallden installation can cut mild steel up to 3/8" thick and 90" wide, with cut lengths infinitely variable up to 48 feet. Change of cut length and synchronization may be made while the Shear is in operation. For every high-production shearing application consult the shearing specialists.

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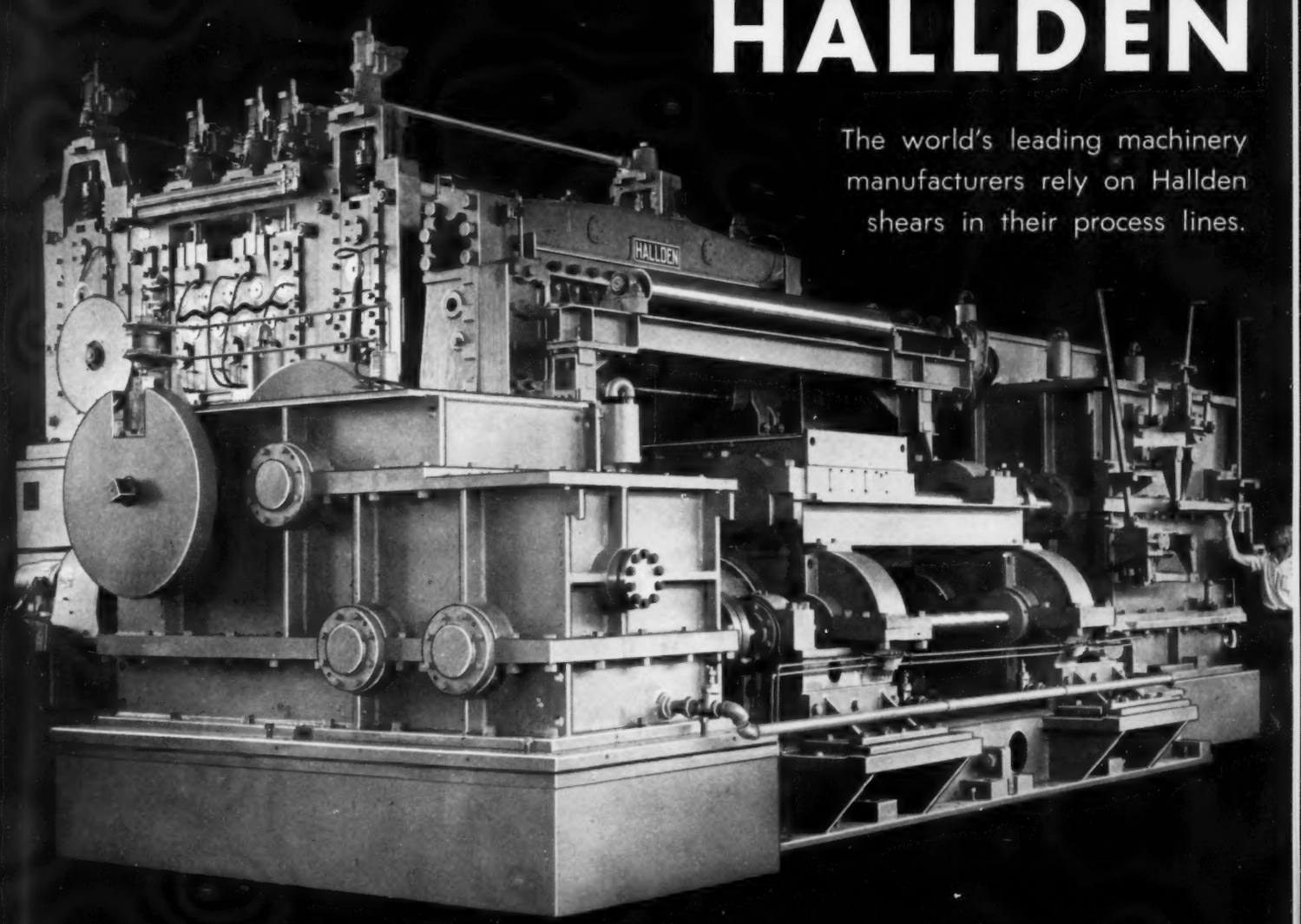

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SUPER #3000—the "NO EQUAL MORTAR" is the lowest cost insurance you can buy. Write for SUPER #3000 SERVICE REPORTS, TECHNICAL DATA, FREE SAMPLE.

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Figure about 350 pounds of bonding mortar per 1000 brick.

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features of gas-shielded arc welding of steel and requires no special equipment. The process produces a quiet, spatter-free type arc for quality welding when used with Airco's new, specially treated A602 Aircomatic wire.

Advantages offered by the process are spatter-free welding, open arc, spray-type transfer, good weld appearance, sound welds, economical deposition rates, continuous wire feed for high work factor and low cost CO_2 shielding gas.

Laboratory data and field trial results indicate essentially no spatter is produced when proper techniques are used. Sound welds can be made with this gas-shielded metal-arc welding process with direct current, straight polarity using CO_2 shielding gas.

The open arc provides ease in welding, with a visible arc lengh of approximately ½ in. About 32 volts is recommended for most work. Under some conditions, a self-peeling light film of slag appears in the weld which is readily removable by dragging a chipping-hammer along the weld, or by simple wire brushing.

Typical applications for the new process are in tubing, landing mats, die posts, piping, car frames, compressor casings, pressure vessels, farm machinery and machine mountings.

The new Airco A602 type wire can be used for single or multipass mild steel applications with deposition rates varying from 7 lb/hr. to 15 lb/hr depending on size of wire and amperage. All metal tensile tests showed an ultimate tensile strength of 70,000 psi and a yield strength of 60,000 psi. Wire is available in 0.045 and 0.054 in. diam.

TRUCK DUST PROTECTION

△A heavy duty dust protection modification for Yale gas powered industrial lift trucks has been designed by Yale Materials Handling Division, The Yale & Towne Manufacturing Co., to reduce maintenance and lengthen engine life in applications where atmospheric contamination is very severe.

The new lift truck modification provides a number of additional safeguards to those supplied in the Yale standard dust protection system.

In place of the dual air filter arrangement in standard dust protection modifications, for example, the heavy duty system provides a triple filtering process: dry type precleaner, oil bath cleaner and a final dry type filter.

A feature of the new dust protection system is the sealing against contamination of the hydraulic system. The filler cap is a sealed fit and the breather line is run from the third stage of the air filter.

The forced crankcase ventilating system, similarly fitted with a sealed filler cap, also is equipped with a breather line off the air filter. A second line directs expelled air into the intake manifold assuring clean air throughout the system.

Features from the standard modification used in the heavy duty system include sealed generator and voltage regulator, a heavy duty engine oil filter and an easily demountable floor dust deflector plate.

Typical of the applications in which dust protection modifications can lengthen lift truck life and cut maintenance costs are foundries, cement plants, abrasive manufacturing establishments, chemical plants and bagged goods warehouses.

PATCHING-RAMMING MIX

△ A new improved formulation of Permanente 84 is being marketed by Kaiser Refractories & Chemicals Division, Kaiser Aluminum & Chemical Corp.

The new version has high intermediate strength because of a new type of chemical bond which persists to higher temperatures. The formulation results in a product which has high strength clear through the patch or bottom. The new mix is easier to shovel because relatively less water need be added.

The material is made from periclase which is scientifically blended and carefully sized in order to obtain maximum bulk density when installed. Permanente 84 gives a high rammed density of up to 170 lb per cu ft and has high resistance to slag and metal attack. Principally, it is used as a hot patching material for basic steel furnace bottoms, banks and tap holes. It has also been widely used for rammed open hearth bottoms and for new bottoms of stainless steel electric furnaces.

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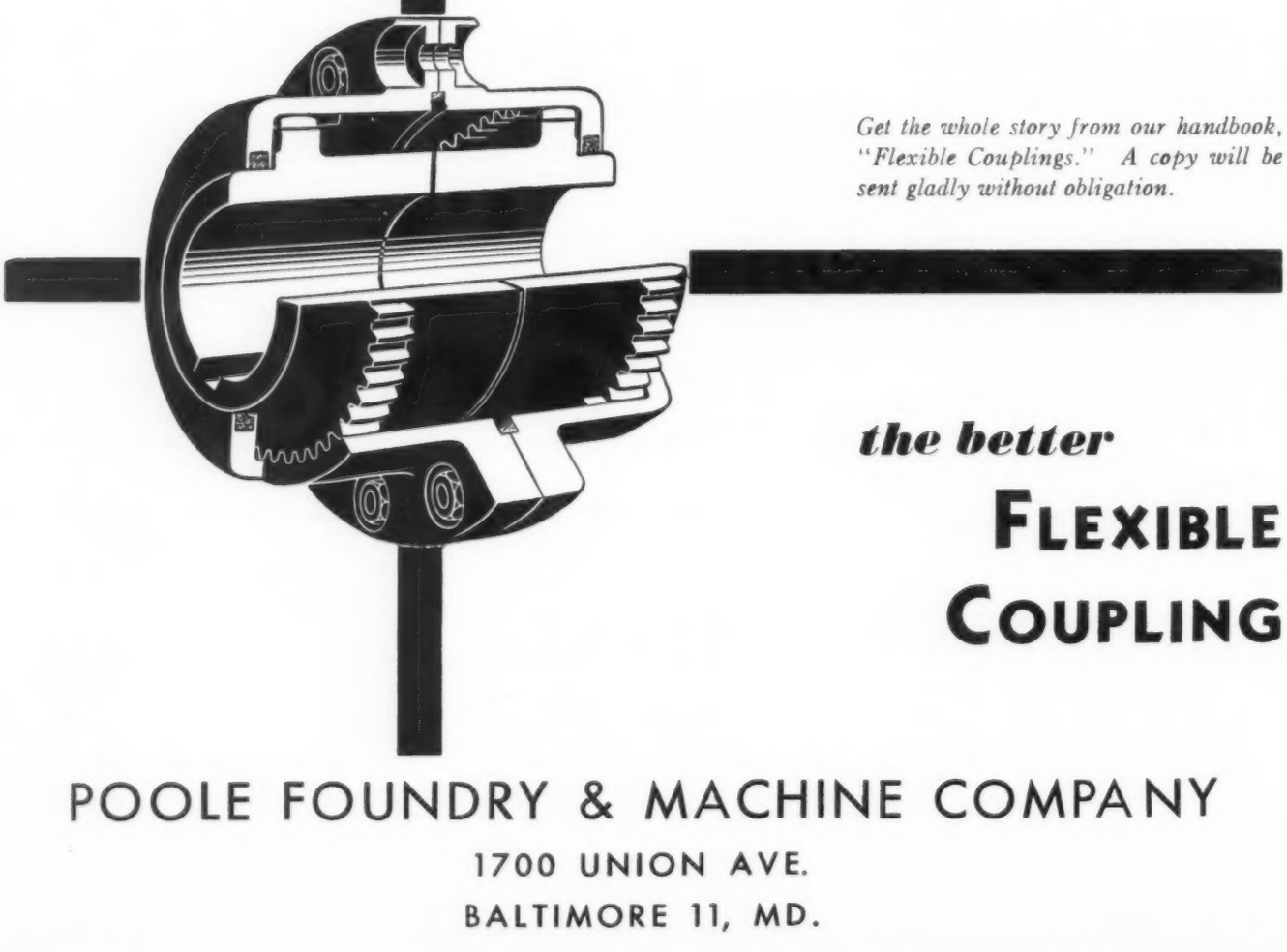

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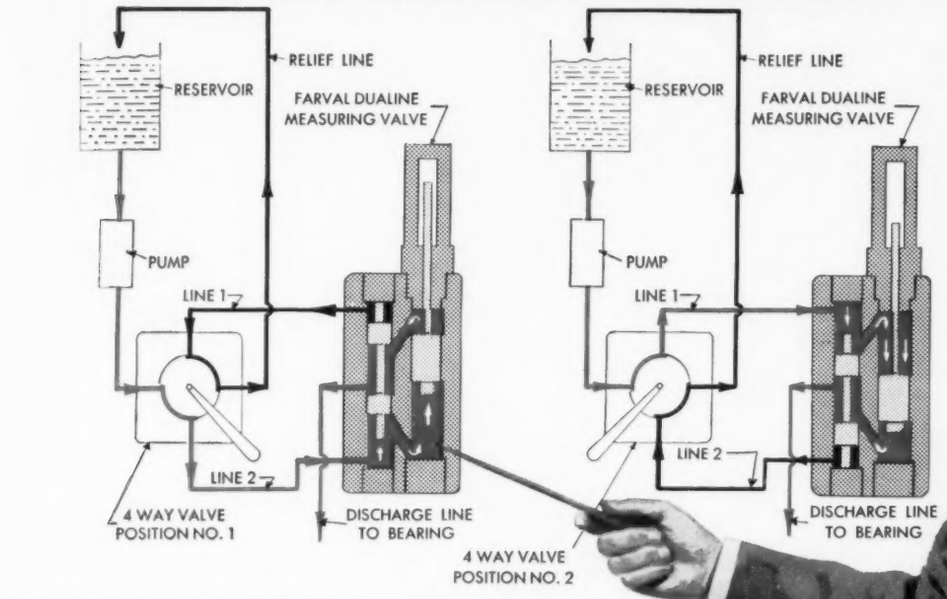

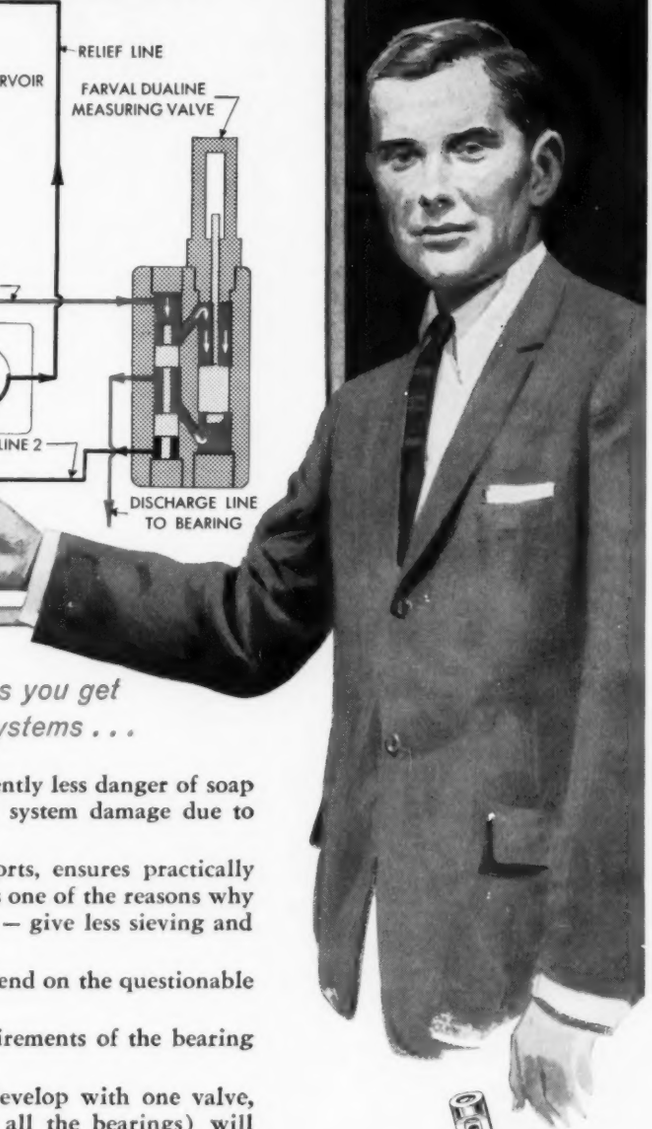

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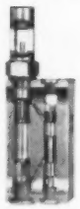

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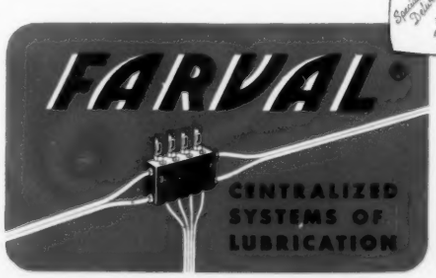

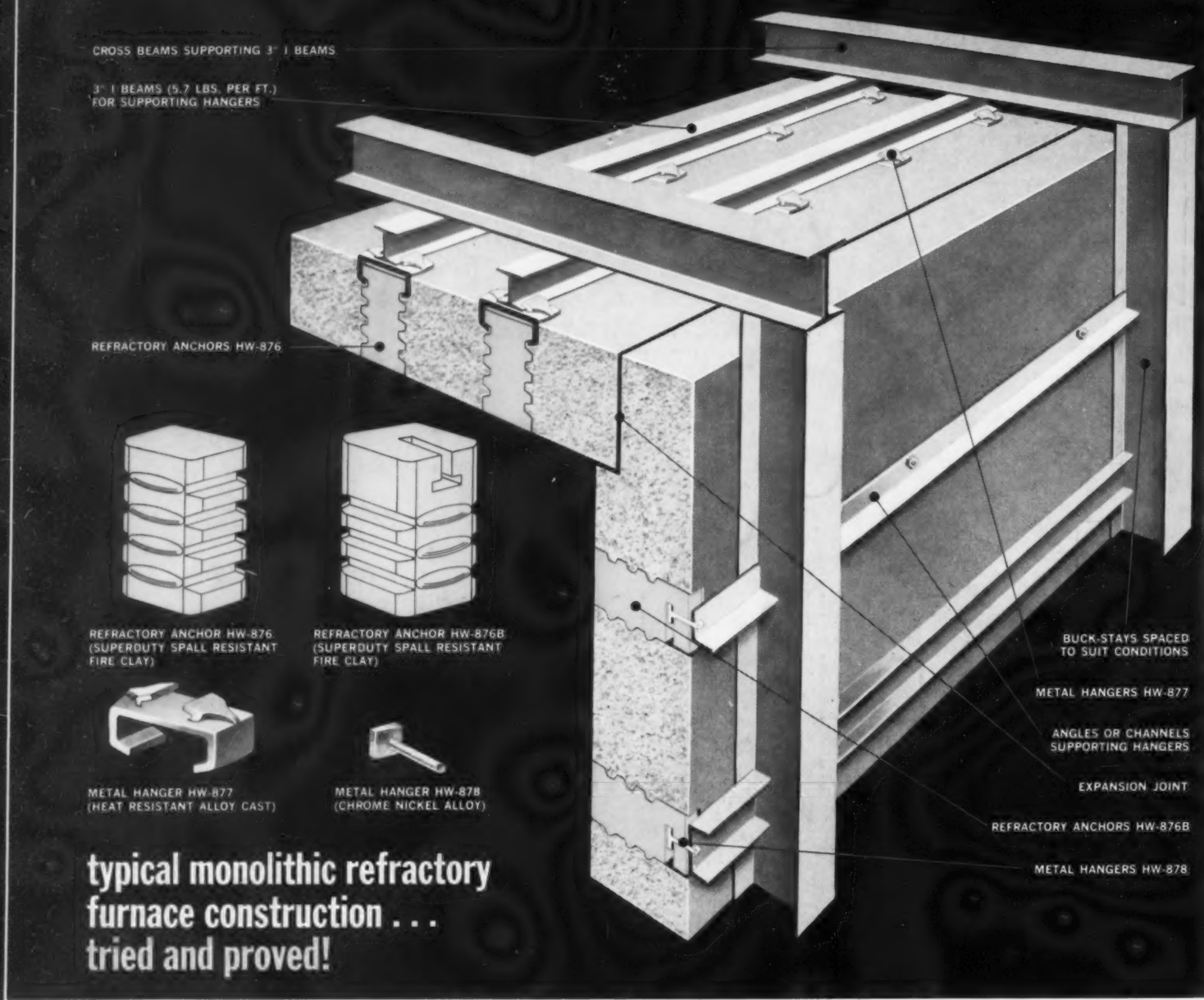
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